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Forthcoming Events.

OCTOBER 27.

Institute of British Foundrymen (Newcastle and District Branch):—Ordinary meeting at Newcastle. "Jobbing Foundry Work from Practical Experience," Paper by C. Bickerton.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Wigan. "The Manufacture and Characteristics of Cast Iron," Paper by S. G. Smith.

OCTOBER 31.

Institution of Production Engineers:—General meeting in London. "Idle Capital in the Machine Shop," Paper by Arthur Easthope.

NOVEMBER 3.

Institute of British Foundrymen (West Riding of Yorkshire Branch):—Ordinary meeting at Bradford. "Non-Ferrous Metals and Alloys in Engineering," Paper by E. L. Rhead, M.Sc.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. "Test Bars—Making and Testing Them," Paper by J. S. Glen Primrose, A.R.T.C.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE
INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

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Neglected Foundry Educational Facilities.

From the Midlands, Yorkshire, Scotland and London we have received reports of the poorness of attendances at foundry evening classes, so much so that in some cases the classes are being abandoned. The average charge for such classes ranges between 5s. and 7s. 6d., but others range between one and two guineas, and the dearer ones are, if anything, the better attended. Thus it can be assumed that it is not the condition of trade which is adversely operating, for we feel certain that if the classes were made free no improvement in attendance would be shown. It is noted that where the attendance at continuation classes has been made a condition for receiving the dole both lads and girls have preferred to forgo the dole.

It seems reasonable to suppose, therefore, that the educational authorities would do well to raise the fees, as there is much evidence to show that free or cheap entities are not appreciated by the class they are meant to benefit. We throw out the suggestion to the committees concerned that they should announce that they will adhere to their obligations to existing students, but all future foundry classes will cost three to six times as much. It may still further reduce the paltry attendances now prevailing, and would, in many cases, resolve itself into individual tuition. We know a number of foundry-class teachers, and are convinced that they are sufficiently enthusiastic to carry on with a very small number, providing the boys appreciate what is being done for them.

We feel sure that an examination of the evening class statistics of one of the large modern universities would reveal that the most costly courses are the best attended.

Speaking nationally, the Institute of British Foundrymen has made the most progress since it has increased its fees. It has attracted and is attracting the best type of men. The character of the papers submitted have never been higher. Metallurgical contributions of the greatest practical utility are now a regular feature of its work, whilst those of a purely practical character invariably show well-trained observational power, associated with a definite appreciation of engineering requirements.

Is it cheapness which is retarding the work of the foundry evening classes, or have foremen been too careless in their choice of apprentices? Surely during the last two or three years there has been an ample supply of the best type of boy labour. Very little effort has been made by the foundries to attract the grammar school or even the public school boy. Are the foundries too ashamed of their gloominess to hope to have recruits from this source, or are they waiting for an *approchement* to emanate from that side? If so, then the announcement that Harrow, the second public school in Great Britain, is to instal a forge and foundry is of considerable interest. The greatest factor in the foundry industry in the future is the social position enjoyed by the managers and foremen. Fortunately, evolution is taking care of this. The foundry owner is becoming very much like any other chairman of a directorate, and now the successful manager possesses a knowledge of metallurgy and engineering, which the former appreciates but has not the time to understand; for this knowledge, which is essentially complementary to his own for the successful prosecution of his business, the foundry owner is willing to pay, and as the results bear fruit, pay handsomely. This is the all-important feature, which will in time remedy the existing neglect of present-day foundry educational facilities by the modern youth.

The History of Non-Ferrous Metals.

At the first meeting of the North-East Coast Section of the Institute of Metals, held on October 9, Professor H. Louis, in his Presidential Address, dealt with the history of some of the non-ferrous metals, of which the following is an abstract. Until comparatively recent times the rate of progress in non-ferrous metallurgy had been extraordinarily slow. The only non-ferrous metals known in pre-historic times were copper, tin and lead; even in classical times no additions were made to this list, though brass was known and used to some extent; of course, nothing was known as to its real nature and, as a matter of fact, this condition of ignorance prevailed for many centuries afterwards. Even throughout the Middle Ages the scope of metallurgy was scarcely widened; it is said that Basil Balentine in the 15th century had prepared antimony, and Paracelsus in the 16th century is credited with having made zinc, but this is by no means definitely ascertained. Even as recently as two centuries ago very little real progress had been made. An English translation of the work by Boerhaave, the famous Professor of Chemistry at Leyden, entitled "A New Method of Chemistry," published in 1727, may be taken as giving a fair summary of the state of knowledge of scientific metallurgy 200 years ago. At this period a metal was held to be characterised essentially by malleability, and the author writes as follows:—"We find but six metals in all nature, viz., gold, lead, silver, copper, iron and tin, though to these the chemists add a seventh, viz., mercury or quicksilver." He goes on to discuss what he describes as the semi-metals, which he distinguishes from metals by not being malleable; these include antimony, which he says consists of three different parts, namely, common sulphur, a poisonous sulphur and a metal of some unknown kind, cinnabar, marcasites, bismuth, lapis calaminaris (which if melted with copper adds a real metallic substance and weight thereto, but diminishes its malleability; the mass resulting from the two is brass), cobalt (which consists of silver and arsenic) pyrites, zinc (which is stated to resemble bismuth in most things; mixed along with turmeric in melted copper it gives the metal a gold colour); the list closes with rock-salt, of which it is stated that it usually contains some metallic heart along with the sulphur. These extracts will suffice to show how little advance in metallurgical knowledge had been made throughout a very long period and make it evident that 200 years ago metallurgical practice was still purely a matter of rule of thumb.

About the middle of the 18th century appears to be the period when scientific methods began to be applied to metallurgy; for instance, zinc was certainly made from calamine in 1741 by Henkel, and two years later the first zinc works in England were started at Bristol. The metal nickel was discovered by Cronstadt and Bergmann in 1751, though it was not produced on a metallurgical scale until 1824. Necessarily the application of electrolytic methods by Davy in this country, Bunsen and others in Germany, and St. Claire Deville in France, about the middle of the 19th century, added largely to our capacity for producing non-ferrous metals such as magnesium and aluminium. It is true that the first-named was for a long time used only as a scientific curiosity for the production of a brilliant light, and the latter appears to have found no real industrial application until aluminium bronze was discovered by Dr. John Percy, in 1855.

The Metallury of 50 Years Ago.

The only important metal which had been added to the list of those available to mankind in over 2,000 years was zinc; aluminium and nickel were being produced in very small quantities and used wholly for the production of alloys; in the same way antimony was being used for hardening and bismuth for increasing the fusibility of certain alloys of lead. Apart from these material results, however, great steps had been made in the scientific understanding of the subject: the scientific study of metallurgy had commenced, and this fact was to make its influence felt in the developments of the industry which followed rapidly.

The world's producing capacity 50 years ago in respect of these metals was, roughly, as follows:—Copper, 160,000; lead, 270,000; spelter, 120,000, and tin, 30,000 tons. The production of all other metals was on too small a scale for accurate records to be obtainable.

Simply contrasting these figures with the world's producing capacity at the present day will show the progress made during the last half century. These figures may fairly be given about as follows:—Copper, 1,400,000; lead, over 1,000,000; spelter, 1,000,000; tin, 120,000, and aluminium, 200,000 tons.

In other words, in this half century the production of copper had been multiplied nine times, that of lead four times, that of zinc eight times, and that of tin four times. Such increases could only be rendered possible by great improvements in the metallurgical processes employed in the extraction of these metals. Professor Louis then dealt with the methods employed at this period for the smelting of copper, describing the so-called German and Welsh processes. The next feature outlined was the rapid development of the copper production of the United States mainly from the native copper ores of Lake Superior, which commenced to produce about 1867, and the decline after 1880 of the Chilian output.

Turning next to the production of lead, Professor Louis stated that the progress in the metallurgy of this metal has been on not dissimilar lines. The principal changes in lead metallurgy may be said to have followed the introduction of what is usually spoken of as blast roasting, the first introduction of which was due to Messrs. Huntingdon & Heberlein, which came into use about the beginning of the present century. This process produced rapidly and economically a material particularly well-suited to blast-furnace smelting, and concurrently the old circular type of furnace was replaced, as in the case of copper, by huge rectangular furnaces as much as 5 ft. wide and 18 ft. in length, so that it is quite possible for one end of the furnace to be undergoing repair whilst active smelting is being carried on at the other end. Such furnaces will put through over 500 tons in the 24 hours. An interesting innovation is the injection of powdered coal to replace part of the coke. Here again, as in the case of copper, the trend of modern metallurgical practice is intensive production, the ores treated being often relatively poor, but available in very large quantities.

In the metallurgy of zinc there is little that is new to chronicle. There is hardly any portion of the process which has not undergone improvement, but there is nothing of definite character to chronicle without going into an amount of detail. In some way the metallurgy of tin has undergone only improvements of the same general character, there being no new principles that have been applied to it.

As far, then, as the more important non-ferrous metals are concerned, the work of the last century has been essentially that of increasing the output as already pointed out and of placing larger quantities at the disposal of the user. It should, however, be added in fairness to the producer of these metals that in most cases this increase of production has not, as has so often been the case, been attended by any deterioration in quality, but rather the reverse. All of these metals are to-day obtainable commercially in a decidedly higher state of purity than was the case half a century ago, and in this respect, at any rate, the task of the user of these metals has been made easier. In addition to the common metals, the modern metallurgist has at his command a great range of rarer metals such as were practically unobtainable half a century ago. At the same time, knowledge of the use of these rarer metals in the production of alloys for all purposes has grown immensely.

Mr. William Cocks, J.P., of Cardiff, died last week at the age of 64 years. Mr. Cocks was, until recently, managing director of the Cardiff Channel Dry Docks & Pontoon Company, Limited, the Bute Shipbuilding, Engineering & Dry Dock Company, Limited, the Mercantile Pontoon Company, Limited, and the Tredegar Dry Dock & Wharf Company, Limited, Newport.

"Moulders" of the Industry.—No. 19.

Mr. C. Heggie.

Mr. C. Heggie, who was born at Carronshore, near Falkirk, was educated at the Falkirk High School. His initial training was with the Carron Company, Falkirk. On leaving Scotland he first went to Leeds, where he was employed with Messrs. Sloane & Davidson, and later with Messrs. Killich & Cockrane, Liverpool, and Messrs. Newton, Chambers & Company, Thorncliffe, Sheffield. His first position as foreman was with Messrs. Watson, Gow & Company, of Etna Foundry, Glasgow. Returning to England, he was apointed departmental manager to Messrs. John Wright & Eagle Range Company, Limited, Aston, Birmingham, and for many years held a highly responsible position with that firm in their design, pattern and foundry departments.

He left this firm to start business for himself, and formed the Birmingham & Midland Pattern-making Company. This firm is now incorporated

Mr. C. Heggie.

with Brookes (Oldbury), Limited, engineers and ironfounders, and Mr. Heggie occupies the position of managing director.

He has always been closely associated with the Institute of British Foundrymen, becoming a member in 1906, when the Birmingham Branch was formed, and taking over soon after the duties of Secretary for the Branch from Mr. F. J. Cook, who held the position *pro tem.*

He was a member of the General Council for several years, being elected in 1907, and was President of the Birmingham Branch for 1913/14 and 1914/15, and his activities relating to the Branch have in no way diminished.

He has given lectures to members of the Institute at London, Leicester, Birmingham, Derby, Sheffield, Manchester, Wolverhampton, and Dudley.

Mr. Heggie is the Birmingham representative on the Test Bar Committee.

The "Sandoil" Competition.

We are asked by our advertisement manager to state that he awarded the five pound prize offered by Messrs. Beecroft and Partners, Limited, of St. Peter's Close, Sheffield, to Mr. D. Whyte, of 8, Vale View, Porthill, Stoke-on-Trent, for his slogan, "Don't Spoil It—Sandoil It." Mr. Whyte is connected with Messrs. Billington and Newton, Limited, of Longport, Staffs., who also receive casks of Sandoil and Ladle Flux. Mr. Whyte, it will be remembered, recently read before the Birmingham Branch of the Institute of British Foundrymen an interesting paper "On the Trail of the Brass Foundry Imp."

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Cast Iron and Mass Effect.

To the Editor of The Foundry Trade Journal.

Sir,—The above interesting and valuable Paper by Mr. Smalley, printed in the issue of The Foundry Trade Journal for September 20, contains two remarks which are, to my mind, the most important ever made regarding our future work on cast iron and ironfoundry practice. They are as follows:—

(1) "Without systematic investigation under standard conditions, considering each of the elements present, one can scarcely draw conclusions on the subject. Similarly, the composite whole involves such a labyrinth of data that it is impossible to formulate any definite statements from our present knowledge."

(2) "It is, however, only by consideration of one variable at a time that a bed-rock foundation can be laid from which scientific principles involved may be estimated."

It may surprise some of your readers to know that the result of applying these sound and scientific laws to the existing literature on foundry practice is to wipe out most of it as valueless. Anyone with a scientific education and training can call to mind dozens of instances where this is true, and very few where it is not.

Ironfoundry knowledge is overflowing with chimerical prejudices, faulty observations, "uncontrolled" experiments, and, consequently, unreliable deductions and data.

By the adoption of truly scientific principles and the application of them to his own work, which, by the way, will entail very slow progress in order, as he says, "to eliminate all variables except the one under consideration," Mr. Smalley proves himself to be among the foremost research workers and thinkers engaged in the investigation of the problems of cast iron at the present day.—Yours, etc.,

H. J. Young.

16, Ashfield Grove, Whitley Bay,
Northumberland.
October 19, 1923.

Company News.

Ibbotson Brothers & Company, Limited.—Directors unable to recommend payment of dividend.

Midland Valves, Limited.—Capital £500. Solicitors: Forsyth, Bettinson & Company, 36, Cannon Street, Birmingham.

Southern European Metals Corporation, Limited, 20, Copthall Avenue, London, E.C.—Capital £150,000 in £1 shares.

P. E. Banting, Limited, 17, Victoria Street, London, S.W.—Capital £1,000. Engineers, etc. Director: P. E. Banting.

S. B. Smith & Company, Limited, 10, Savoy Street, London, W.C.—Capital £1,000. Engineers, etc. Director: S. B. Smith.

Victory Valves, Limited, Adswood, Stockport.—Capital £10,000. Directors: T. F. Gray, E. A. Radford, and E. A. Bolton

R. Hartley, Limited, Back Lane Works, Baxenden.—Capital £1,000 in £1 shares. Engineers. Directors: R. Hartley and W. Hudson.

Ashton Vale Iron Company, Limited.—Loss, £5,322; debenture interest, £364; debit balance brought forward, £1,652; deficiency, £7,338.

British Chilled Iron & Steel Company, Limited, Ainstree Street, Barrow-in-Furness.—Capital £10,000 in £1 shares. Directors: A. F. Tosh and H. Orrell.

Stothert & Pitt, Limited.—Profit, £11,380; brought forward, £7,020; available balance, £15,384; ordinary dividend, 5 per cent., free of tax; carried forward, £5,805.

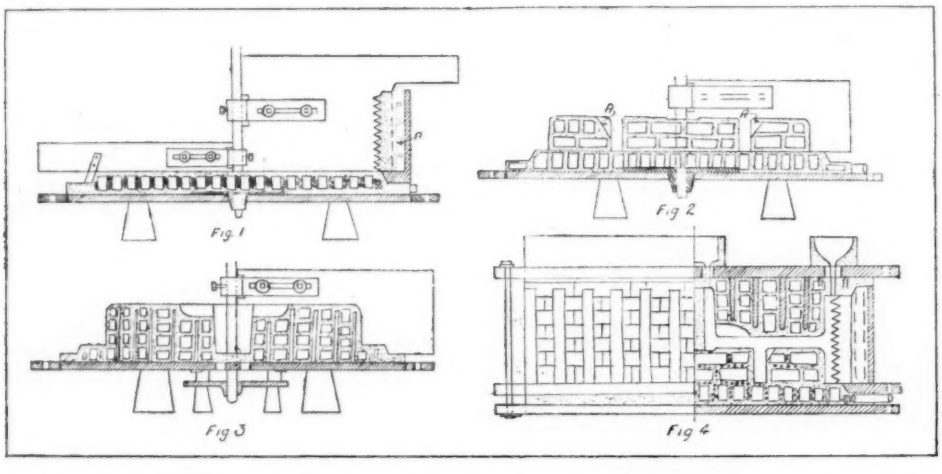
Mr. J. J. McClelland has resigned his seat on the London Branch Council of the Institute of British Foundrymen, on account of his leaving the London district for South Wales, where he is establishing himself as a consulting engineer and as the South Wales representative for Messrs. James Evans & Company (Manchester), Limited. Mr. McClelland's address will be Druslyn, Bishops Road, Whitchurch, Cardiff.

Making a Rope Pulley and Clutch Combined in Loam.

By A. Greenhalgh.

For the making of this job three plates are required. One for the bottom, a ring plate with prongs to lift the grooves away, and a plate for the top, this plate must have prongs also, for the lift in the top. The bottom plate is set upon three stands. If an ordinary three-legged seating is used for spindle, this can, at the outset, be put on the plate and the spindle inserted. The arm with straight strickle board is fastened on the spindle. Loam is now placed all over the plate, and in this are set bricks on edge. Small ashes are placed between the bricks and trailed away with a small pipe to the outside. A piece of wood is tacked to the strickle, to form the joint for the ring plate. More loam is then put on the bricks and strickled off, leaving a level bed as in Fig. 1.

The board having been taken off, parting sand is placed on the sloping joint. The ring plate is now bedded on soft loam so that the surface of the plate is just below the level of the bed. The strickle for the grooves is placed in position, the bottom edge just touching the bed. The groove cores having been first rammed up and dried make it an easy matter to set them to the strickle board.



Soft loam being first placed on the plate, just sufficient to form a seating for the cores, the space between the cores and prongs of the plate being filled in with a single row of bricks, the joints of the cores are filled up. The whole can now be "slipped" up. After the loam has stiffened the ring plate can be lifted away and put in the stove. At A, Fig. 1, is shown the groove cores and ring plate. The strickle board, to make the bottom of the mould, is now fastened to the arm. As this board will form the clutch, and the plate of the pulley a little more building will be necessary. Ashes being placed between the bricks and connected to the lower cinders. Small brackets are added to the outside of the clutch to give strength. These are inserted after the mould has been built up.

Fig. 2 shows the bottom of the mould with the brackets, indicated at A. After being "roughed up" the mould is allowed to stiffen. Afterwards it is "slipped up," that is, finished with soft loam which has been put through a sieve. It is now ready for the stove. The top plate can now be placed on the same stand. The spindle seating being fixed underneath the plate. If it had been placed on the plate, as on the bottom plate, it would have been in the way of the runners. Bricks are used to form the boss. These are set at such a distance from the plate, that the strickle board will clear the prongs. Building up can now be commenced, spaces between the bricks being filled with small ashes as in the bottom part, the gas escaping through holes in the plate. When it has been bricked up nearly level with the top of the boss, strengthening brackets are bedded in. The whole can now be roughed up; after setting it is slipped up and ready for the stove. Fig. 3 shows top part.

After the mould has been thoroughly dried it is dressed, that is, rubbed over with sandpaper where necessary. When this is done, a good coat of wet blacking is applied, the heat of the mould drying-out this. The bottom part is now put on a level bed and cleaned out. The ring plate is now placed in position. The centre core of the boss is put in, and the top is ready to be tried on. The job is run on the boss, risers being taken off the rim. Runners and risers are made up, and the job is ready for casting. Weights or bolts being used for holding the mould together as is convenient: Fig. 4 shows finished job ready for casting.

New Non-corrosible Alloy.—The Swedish company Ferrolegeringar is reported to have succeeded in producing a new chrome-iron alloy, which has all the qualities of soft iron but which is non-corrosible.

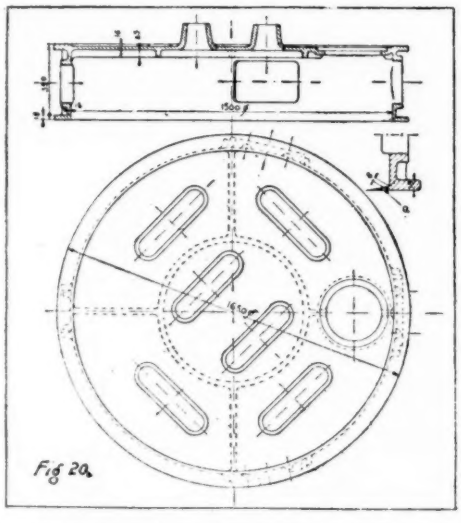
Breakdown Tests of High-Speed Tool Steels.—Technological Paper, No. 228, of the U.S. Bureau of Standards, deals with comparisons of performance of modern high-speed tool steels in lathe breakdown tests, in which endurance of tools is measured under definite working conditions, and likewise with the limitations of this method when applied to the purchase of steel. The modern steels are first classified according to chemical composition, and this division is made use of in discussion of results obtained. Important features developed or conclusions drawn may be summarised as follows: (1) Breakdown tests are not satisfactory as the basis of purchase for high-speed tool steels. (2) While competitive comparisons of brands of nearly similar performance are not justified, owing to the qualitative nature of this type of test, relatively large differences may be ascertained with certainty, providing sufficient tools are tested and averages of at least two grinds are used in interpretation of results. (3) In certain severe breakdown tests with roughing tools on 3 per cent. nickel steel forgings, in which high frictional temperatures were produced, it was found that the performance of commercial low tungsten-high vanadium and cobalt steels was superior to that of the high tungsten-low vanadium type, and special steel containing about ¼ per cent. uranium or ¾ per cent. molybdenum. The average power consumption in all cases was practically the same, so that this factor need not be introduced in comparisons which may be made on the basis of endurance of the tools. (4) Modification in test conditions, including small changes in tool angles but principally changes in cutting speed, more markedly affected the performance of steels containing cobalt or special elements such as uranium or molybdenum than that of the basic types (plain chromium-tungsten-vanadium steels). (5) The relatively poor endurance of the high-tungsten steels under severe working conditions was not observed in more moderate tests which were made on the same test log with equal cutting speed and depth of cut, but with reduced feed, and in which the frictional temperatures produced were not so high. Also in these latter tests the performance of the cobalt steels was better than either the low- or high-tungsten steels. (6) Hardness determinations and examination of fractures indicate that the various types of commercial high-speed steel show differences in behaviour under heat treatment and in physical properties which probably are of importance under moderate working conditions, and might counterbalance slight advantages in performance

The Use of Cast Alloys for the Working Parts of Machinery.*

By Mons. Pisek, President of Czecho-Slovakian Foundrymen's Association.

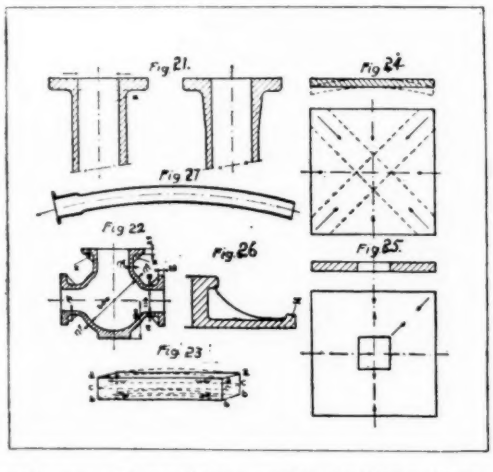
(*Continued from page* 329.)

Fig. 20 illustrates the cover of a still. A fin "a," almost $\frac{3}{8}$ in. thick, was formed all round the piece. The strains set up by the contraction of this fin were sufficient to cause cracks all round the circumference, and the casting had to be scrapped. Another great fault in design, from the founder's point of view, is an accumulation of metal on one part; a flanged pipe (Fig. 21) is a

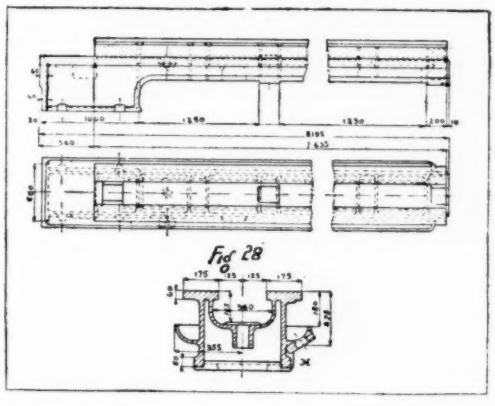


simplified example. The walls of the pipe have solidified and finished their contraction before the flange has set, with the result that severe cooling strains are set up in the flange when it solidifies. To reduce these strains the walls of the pipe should be thickened, as shown in the illustration.

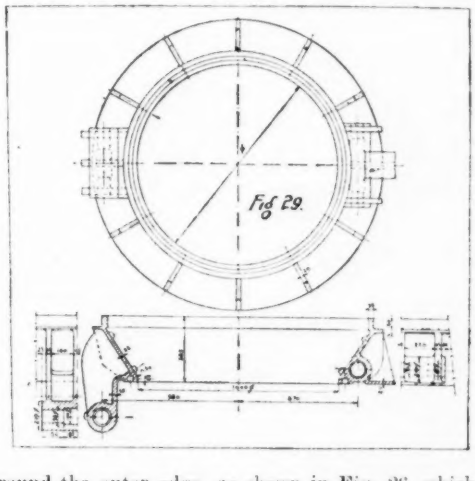
Objects cast in alloys having great contraction are liable to crack where a thin section joins a



thick one. To avoid these cracks, the thin sections are provided at intervals with thin webs, which connect with the heavy parts. These webs, shown at "x" (Fig. 22), are the first to solidify, and then rapidly absorb the heat from the thicker metal, the setting of which is thus accelerated. At the same time, these webs reinforce the parts during the plastic stage. Under certain conditions, contraction stresses may result in deformation of the casting. Fig. 23 illustrates a cast bar of square section. Suppose, after casting, that the side "aa" cools more quickly than the side "bb," and that this cooling acts as far as the centre plane "cc." The moment the bar ceases to be ductile, the rapidly cooling part cannot contract freely; it is hindered by the part which is cooling slowly. Tensile strain results. The slowly cooling portion begins to contract later, but, since it is united to the quickly cooling portion, it tries to accelerate its shrinkage, with the result that this portion is put in compression, and the bar is deformed, as shown by the dotted lines



in Fig. 23. The cast-iron plates shown in Fig. 24 were distorted from this cause. If these plates were cast in open moulds, the deformation can be avoided by covering the surface of the casting with sand, which is removed across the diagonals; by this means the cooling will be equalised, and the plates will remain flat. If the plates are cast in closed boxes, the provision of a square hole in the middle, as shown in Fig. 25, allows cooling to take place in two directions. A device frequently employed is to cast a thickened beading



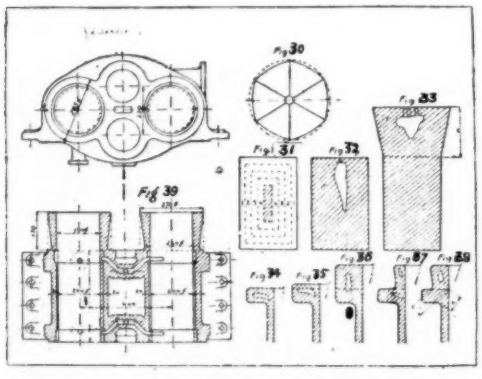
round the outer edge, as shown in Fig. 26, which reduces the rate of cooling at the edge. As a general rule, it is necessary to reinforce, by means of webs and ribs, castings which are liable to distortion, machine bed-plates for example.

Long objects with an accumulation of metal along one side are very liable to distortion; pipes, the walls of which are of unequal thickness, are certain to become deformed, as shown in Fig. 27, owing to the slower cooling of the thick side. This form of distortion raises a great difficulty in producing long castings in which unequal distribution of metal cannot be avoided, as, for example, lathe beds. In order that the upper surface, which is very massive, may be sound, it

* Translated and abstracted from a Paper, presented to the Paris International Foundry Conference.

is necessary to have this portion at the bottom of the mould, a position which makes it impossible to accelerate cooling by the application of water. It therefore becomes imperative to reinforce the thinner parts of the casting to avoid distortion. Reinforcement of this nature is shown at "xx" (Fig. 28); it reduces but does not eliminate the strains. To correct the distortion that will still occur, it is usual to camber the pattern in the opposite direction; the amount of camber is a matter of judgment and varies for each case.

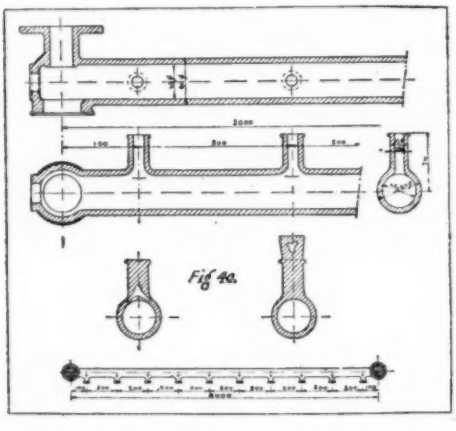
Such a casting as shown in Fig. 29, having accumulations of metal on opposite sides, will



never retain its circular form but will be more or less oval, the amount, which may be up to ½ in., depends on the casting temperature and the composition of the iron. For the same reason a cast-steel wheel is never circular as cast, but is distorted as shown (exaggerated) in Fig. 30. The webs hold on to a section of the rim, which then becomes slightly flattened.

Piping and Blow-Holes.

There is another evil arising from shrinking, viz., the formation of cavities or pipes. Considering the case of a cast cylinder and that the liquid metal solidifies uniformly throughout. The first layer to solidify will be that adjacent to the walls of the mould, marked "1" in Fig. 31. This layer will then contract, next the layer marked 2 will solidify and contract, then the layer 3 will follow suit; finally, when the last portion has completed the process, a cavity will be left in the centre. That is what would happen if the metal was at the same temperature throughout and solidification proceeded uniformly. In practice, however, the metal which is first in the mould is



the coldest and solidifies very quickly, whilst that in the upper portion remains liquid for some time longer. Consequently the cavity is formed in the upper section of the cylinder (Fig. 32). Since the cavity is devoid of air, the pressure of the atmosphere causes cracks in the soft metal, which it penetrates. The cavities are particularly dangerous, because they are out of sight. If the solid cylinder be extended to a suitable length the pipe will form in the extension, leaving the rest of the casting solid, Fig. 33. This "riser" or "head" is the last portion to solidify, and so helps to feed the body of the casting. Naturally, the more the metal contracts the larger will be the cavities. Considering the case of a very thick flange on a pipe with thin walls, it will be seen to approximate to that described above. The walls solidify very quickly and contract, whilst the flange is solid only at the surfaces. The walls, therefore, draw metal from the still liquid portion in the centre of the flange. In time the whole mass solidifies, leaving a cavity in the flange as shown in Fig. 34. To avoid this cavity the centre portion of the flange must be fed with liquid metal; that is, a riser must be furnished, and the best form for this must be considered. If the flange is simply made thicker the matter becomes worse (Fig. 35), because, when the flange is machined the cavity is exposed. One way of attaining the end would

Fig. 41.—Illustrating a Pipe in a Brass Tube Casting.

be to thicken the flange still more (Fig. 36), but this would entail a waste of metal, and would make machining costs very high. If, on the other hand, the head is made as in Fig. 37, the effect illustrated will occur. The passage between the head and the flange is narrow and soon solidifies, with the result that a pipe still forms in the flange. To be correct, the head must be as shown in Fig. 38, in which the passage between head and flange must be a little wider than the greatest thickness of the flange measured as shown at "x."

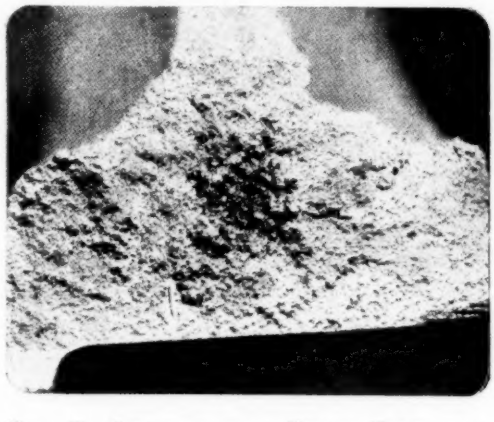
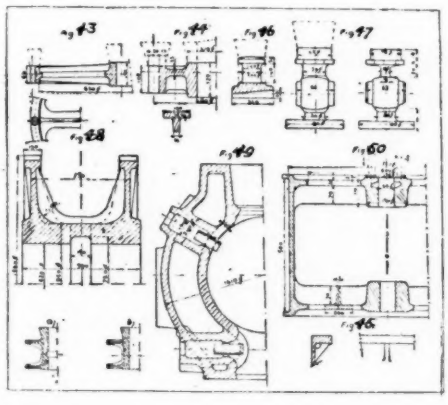


Fig. 42.—Structure of a Drawn Place in a Flywheel.

Fig. 39 shows the casting of the steam cylinders for a steam plough. The full lines indicate the correct form of feeder head, whilst the dotted lines show an incorrect design. Sometimes these cavities are very large. Fig. 40 shows a main pipe in brass. Originally the pattern was made to permit moulding with the branch pipes downwards; as a result serious piping occurred. By altering the pattern and providing risers piping

was avoided. Fig. 41 shows the fracture of one of these tubes at the cavity. Even where there is no great difference in the thickness of the metals, this portion is always porous, as shown in Fig. 42, which shows the fracture of a small flywheel at the point where the web enters the rim.

Cavities also form in gear wheels, the rims of which must be cast in one piece; they generally occur at the points of junction between the arms and the rim. To avoid this, risers must be furnished at the danger points as shown in Fig. 43.



When cast-steel gear wheels are cast in one piece it is better to use arms of the form shown in Fig. 44. Since the provision of very strong arms would mean large accumulations of metal, it is usual, especially when using a metal with high contraction, to lighten the arm by employing the section, Fig. 45. Sometimes, in order to avoid piping, it becomes necessary to make the unimportant sections as strong as those subjected to stresses. Examples are shown in Fig. 46; the ladle trunnion, which has been cast 200 mm. dia., whereas the finished size was 140mm. Fig. 47 shows a manganese bronze valve body as cast—on the left—and as finished—on the right. When the design is bad, it is very difficult to avoid

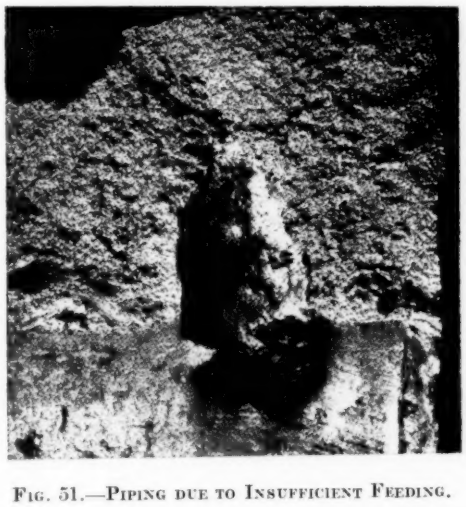
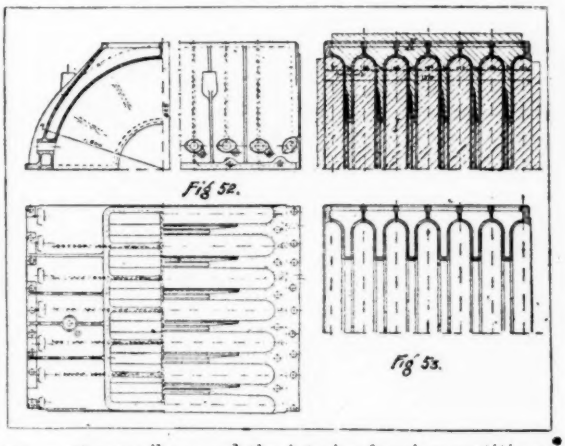


FIG. 51.—PIPING DUE TO INSUFFICIENT FEEDING.

piping. In the example illustrated by Fig. 48 there are two faults: the boss is very massive and the use of feeders in the lower portion was without useful result; cavities always formed at the points "*a*" and "*b*" in the lower portion. This casting should be made in two portions, as indicated by the dotted lines. The employment of chills makes it possible to avoid porosity by quickly cooling the metal. This device is shown in Fig. 49, where parts of the cores are made of some good heat conductor. Fig. 50 is an example of a difficult casting. It is a drum with very strong arms and a massive boss. The metal was run at the boss, the arrangement being shown dotted in the figure. Cavities were formed at the junction of the arms with the rim and in the boss. In the latter case the upper skin of metal, unable to withstand the pressure of the air, was crushed in as shown by Fig. 51. This type of defect frequently occurs when steel or aluminium are cast without risers. In general, to avoid cavities, it is necesary to direct the molten metal to the thin portions of the casting. It has been remarked that design has a great influence on the formation of pipes. Fig. 52 illustrates a casting in which design plays a very important part. The upper view is of the cover of a turbo-compressor having



strong ribs round the interior forming partitions. The mould consists of two loam cores reinforced with strong iron grids. The dimensions of this casting was almost identical with those of the pattern. There was practically no contraction; in a length of nearly 5 ft. the contraction was only $\frac{1}{8}$ in. The explanation was that the cores were incompressible, and the expansion of their iron grids, owing to the heat of the surrounding metal, acted against and impeded shrinking. These iron frames were only a few sixteenths from the divisions. This explanation was confirmed when the design was modified as shown in Fig. 53. In this case the iron grids were further from the walls of the casting, and their expansion was nullified, with the result that the contraction of the casting amounted to 0.6 per cent.

The conditions under which a casting is to be used also influences the design. As an example, parts that are subjected to changes of temperature. Every increase of temperature is accompanied by expansion. In the design this expansion must be allowed for, which means that strengthening ribs cannot be used, since they set up tensile strains. This is why gas engine pistons are provided with only two shallow ribs or, better still, none at all, although from the point of view of heat transfer when working the position would be improved by the addition of ribs. Aluminium pistons, on the other hand, are provided with a number of ribs. This is possible owing to the great heat conductivity of aluminium. The specific gravity or density of the alloys depends on the shrinkage and on the number of blow-holes enclosed; generally speaking, it is less than that of the constituent metals.

Resistance to corrosion by chemicals varies with the alloys; sometimes it is greater, and sometimes less than that of the constituents. Electrical conductivity of alloys is always less than that of the constituent metals. The properties of colour, heat conductivity and magnetism are not of great interest to the foundryman.

Having dealt with the alloys from a general point of view, it is now necessary to say something about particular alloys.

(To be continued.)

THE BURNLEY TOWN COUNCIL have placed an order with Spencer-Bonecourt, Limited, for the installation at Burnley Gas Works of a waste heat boiler equipment for the utilisation of waste heat in connection with their gas retort settings.

GLENFIELD & KENNEDY, LIMITED, of Kilmarnock, have booked a repeat order from the Royal Irrigation Department of the Siamese Government for two steel sluice gates 41 ft. $0\frac{1}{8}$ in. by 19 ft. $8\frac{1}{4}$ in. deep, similar to those mentioned in our last issue.

Designing and Equipping a Foundry Laboratory.

By H. H. Shepherd, M.I.Brit.F.

(*Continued from page 332.*)

Gas Supply.

As previously remarked, this should be delivered at a good pressure, and the "lead in" main should have a diameter of 1½ to 2 in., the piping for the muffle connection ⅝ in., and for Bunsen taps ¼ in. to ⅜ in. dia.

Lighting.

The artificial lighting of a laboratory is a matter of considerable importance, and it should be given attention worthy of this. The ideal light is undoubtedly a colourless and diffused one, but this ideal is—in so far as the writer is aware—almost impossible of attainment. The Tantalum, Nernst, and enclosed arc type of electric lamps possess illuminating properties which are probably nearest in their similarity to daylight to that of any other type of artificial light. The Tantalum and the Nernst lamps give a white light which is very suitable for colour matching.

The most efficient system of artificial lighting yet devised is that known as the indirect or concealed light system, such as is employed in the modern offices, showrooms, etc. The light is projected from its source—which is hidden by opaque or semi-opaque bowl-shaped reflectors—on to the ceiling, which should be of a light decoration, preferably white, and is reflected downwards in such a manner as to illuminate the room with evenly diffused light, giving an effect which tends more to that of natural light than any other lighting system.

For general work close proximity of artificial light to the worker should be avoided; if a direct lighting system is employed, then the light should be at the back and to the right of the worker; for this latter system half-watt lamps, frosted and provided with wide but shallow white porcelain shades, are the most suitable.

Heating.

Self-contained hot-water radiators are suggested for heating the whole building.

Ventilation.

The ventilating scheme recommended may be termed a semi-natural one. An absolute natural ventilation, by windows and ventilators, is not—even at its best—very efficient in respect of its application to a laboratory. The exit of fumes is very slow, since reliance must be made on the convection properties of warm air. To ensure a comfortably free-from-fumes atmosphere in the laboratory, removal of fumes by forced draught is necessary. In the scheme to be described here there are three main fume exits provided, two being situated in the hood of the ignition bench and a third is a ceiling ventilator situated on the opposite side of the laboratory. Its approximate position is shown by Fig. 1, No. 46. The ventilating pipes are fitted between the ceiling and the roof proper, and sheet-iron piping of 7 to 9 in. dia. will be found quite satisfactory. Connection to the main exit is made, the latter being also of sheet iron and of such shape and diameter that a suitable suction fan can be fitted at the exit end, Fig. 3, No. 48. A fan suitable for this size laboratory is one having a diameter of 11 in.; direct coupled to a D.C. motor, its capacity should be about 1,300 cub. ft. per minute. The fan starter is fixed at a convenient height, say 4 ft., against the wall, Fig 3, No. 41. The fume cupboard and ignition bench exits should be of 4-in. earthenware pipe, leading into the secondary exit, Fig. 3, No. 45, which should also be of earthenware.

The ignition bench hood should have a length and width equal to that of the bench. A very neat and durable type is that made by Messrs. Baird & Tatlock. It is of strong angle iron fitted with Poilite panels.

It may be worth while to draw attention to the incline of the secondary exit or main commencing at the first ignition bench exit.

Special Equipment.

The most important piece of laboratory equipment is undoubtedly the balance; it is the foundation of all of the work undertaken in the chemical laboratory. It is primarily responsible for the accuracy of analytical work, and it is essential, therefore, that every care should be taken when purchasing a balance. To buy a cheap one without first assuring oneself that it is sufficiently accurate for all classes of analysis of which it is likely to take part is foolish. The writer does not recommend any particular make, for it is his experience that there are many very reputable and very accurate working balances on the market, and in many instances the only difference is that of price.

For rapid work, as in the case of industrial laboratory work, a short beam balance will be found a distinct advantage as compared with the older type of balance having a long beam. It may be said that a long beam gives greater sensitivity, but the short-beam instrument of modern make by a reputable maker leaves nothing to be wished for on the score of accuracy or sensitivity.

For analytical work the balance should possess a maximum capacity of from 100 to 150 grammes and a sensitivity of $\frac{1}{10}$ milligram. The care that is necessary in regard to the purchasing of a balance cannot be too strongly emphasised, also in respect of the purchasing of weights. A first-quality set of weights from 50 grammes to 1 milligram should be provided; the fractions of a gramme should for preference be of platinum, but as these are very expensive, aluminium fractions are usually supplied, and they form a very suitable substitute.

In addition to at least one fine balance, a coarse balance will be required for the weighing of chemicals, rough samples, etc. A balance of 250 grammes capacity and sensitive to 1 milligram, fitted with 3 in. to 4 in. dia. pans, and protected by a glass case will meet this requirement. A set of weights of 250 or 200 grammes to 1 milligram should be supplied for use with the coarse balance.

The furnace used for the determination of carbon in iron, steel, etc., can be of electric- or gas-heated type. If electricity is not at hand and the latter type of furnace is adopted, the Huxley pattern furnace should be used. The gas furnace has for the most part been superseded by the more efficient electric furnace, and a universally used pattern is illustrated by Fig. 11. This furnace will heat up to 1,000 deg. C. in a very short time, and it requires little or no attention to keep it at practically constant temperature. It is provided with a temperature regulator and control panel.

In addition to a carbon furnace a muffle furnace forms part of necessary equipment. A very satisfactory type is shown by Fig. 12; it is made by Messrs. Fletcher-Russell, of Warrington, and is known as the "661" pattern. The "heating up" of this furnace is uniform and fairly rapid; a high temperature can easily be obtained without excessive gas consumption.

A convenient size for the hot-air oven is one of 9 in. × 9 in. × 9 in. dimensions. It should be of sheet copper; iron is not recommended as it rapidly rusts and corrodes under the action of acid fumes and moisture.

The water still and water oven suggested are of combination pattern. It is specially referred to because of its very practical and economical value. It has several advantages over the ordinary type of still or water oven, one important advantage being that it only occupies the space of a still or of an oven. There is a combined water and gas control to the still, and the output of distilled water is about 6 pints per hour. A further advantage is that the oven is fitted with six evaporating holes, and the writer has found these to be extremely useful. The apparatus

is made by Messrs. W. & J. George & Company, of Birmingham.

Another useful apparatus is a grinding motor, illustrated by Fig. 14; it is very satisfactory for the grinding of coal, coke, slag, etc. Preparation of the sample is rapid, and is produced in fairly fine and uniform state of division so that sieving operations are cut to a minimum.

A small electric-power bench grinding and polishing machine having a double spindle to enable wooden discs to be fixed greatly facilitates the work of grinding and polishing specimens for micro-examination. The employment of a double spindle allows for the use of a series of wooden discs to which are fixed grinding and polishing papers.

Some workers object to mechanical polishing, but as in works practice it is usually necessary for the examination to be conducted rapidly, mechanical polishing is invariably adopted; if and when hand-polishing is desired, one cannot do better than adopt the admirable and simple method and apparatus described recently before the Newcastle Branch of the I.B.F. by Mr. Colin Gresty.*

The important position to which the use of the microscope has risen in connection with metallurgical work has been remarked upon previously, but no harm can result from emphasising that a microscope is not a luxury but a necessity in modern metallurgical investigation work.

The type of instrument recommended is the horizontal pattern, and for ordinary works practice an elaborate microscope is unnecessary. Watson's "Junior" or "Metallurgical 2" are very efficient types. The "Junior" pattern is not fitted with a mechanical stage as is the "Metallurgical 2"; this is undoubtedly a disadvantage for rapid work. It can be used in conjunction with, preferably, a horizontal camera and condensing system. For illumination one cannot do better than provide a 100-c.p. Pointolite lamp.

In the outlay and costing of the laboratory allowance has been made for a transverse-tensile testing machine. To a modern foundry a transverse testing machine is indispensable, but there is a tendency to drop the tensile test. The latter test is, however, very useful for supplying information to the foundry manager or metallurgist as to the tensile strength of the metal even if its value as a specification test is doubtful.

A suitable type of machine which covers the physical testing requirements of most foundries is illustrated by Fig. 15. It is designed to permit transverse and tensile testing. Transverse tests can be made up to 50 cwts. on bars of any section up to 2 in. × 1 in., and having spans of 12, 24, or 36 in. The load graduations are in 28 pound divisions, and the deflection scale reads to 0.001 in. The tensile scale has graduations of 28 lbs. up to 80 cwts., but the actual capacity of the machine permits a maximum graduation of 5 tons being made if desired. This brings the reading and testing capacity of the machine more into line with the requirements of modern foundry practice, since it is now fairly common practice for foundries producing good-quality castings to produce regularly metal having a tensile strength of 18 to 20 tons. The tensile test is made on a test-piece having an overall length of 6 to 8 in., and a diameter of 0.564 in. (0.25 sq. in.) between 2-in. gauge length.

If it is necessary to make a large number of tensile tests on the larger and more or less standard tensile bar, then a greater capacity machine will be required. The machine shown in Fig. 16 is particularly suitable for this class of testing: it is provided with accessory tools for the making of transverse, bending, compression, tension, and shearing. A suitable capacity for this type of machine is 10 or 15 tons, and for large general engineering foundries the machine described is more suitable than the smaller one (Fig. 15). The large machine is not included in the costing.

The acquisition of a platinum crucible is not absolutely necessary for ordinary iron analysis, but for non-ferrous work as in the analysis of aluminium alloys it becomes an essential piece of apparatus. A suitable size will be found in one having a weight of about one half ounce troy, and measuring 1½ × 1 in. diameter.

A calorimeter should form part of the equipment of a foundry laboratory; discretion should be used as to the type purchased, there are several patterns of instruments on the market, some very elaborate, and yield very accurate results; but with the possible exception of research work, an elaborate instrument should not be acquired. The axiom in works testing is that the degree of accuracy attempted should be determined by the degree of fineness to which the results obtained can be applied in practice, hence an apparatus which will give sufficiently accurate results comparative to their practical application becomes a valuable asset to a laboratory if only from point of view of cost. In respect of a calorimeter the writer strongly recommends the Lewis-Thompson type.

The Estimated Cost.

It need hardly be mentioned that to give a figure as representing the cost of equipping a laboratory is a matter of considerable difficulty, except, of course, if it be backed by an actual instance. The writer has, however, been very fortunate in this direction in securing the very valuable aid of Messrs. Baird and Tatlock, laboratory furnishers, of Hatton Garden, London, who very generously offered to submit an estimate of the cost of furnishing and fitting a laboratory in accordance with the writer's design; for this help the writer is deeply indebted.

In arriving at the total cost of the laboratory the writer has taken as a foundation the requirements of the laboratory of a large foundry and engineering works with which he is well acquainted, and it is pointed out that this estimate includes the requirements of a small brass foundry and other non-ferrous analytical work, therefore the cost given will be somewhat in excess of that actually required by a single unit, namely, an iron foundry only.

Building, decorating, heating, and lighting costs are not included in the estimate, cost of a lathe or drilling machine is also excluded, but gas and water fitting, and also cost of fixing benches, etc., have been considered.

Below is given a summary of the more important items included in the estimate; the amount considered for chemicals has been such as to meet the requirements of a laboratory for from two to four months, according to the nature and quantity of the tests made:—

Complete furniture and fixtures for laboratories, dark-room and office.

Earthenware, channelling for drainage system, exclusive of fixing costs.

Ventilating system,, supplying and fixing.

Tensile and transverse testing machine, as illustrated by Fig. 15.

Metallographical outfit, including microscope, camera and all accessories.

One fine chemical balance and weights.

One coarse balance and weights.

Still and water oven.

Hot-air oven.

Electric carbon furnace and accessories.

Platinum crucible.

Lewis-Thompson calorimeter.

Grinding and polishing machine.

Grinding mortar.

Burner and plate for fume cupboard.

Glassware, burners, retort and tripod stands, porcelain ware, etc., etc.

Chemicals.

The total estimated cost covering the items as indicated above is approximately £800.

Concluding, the writer desires to express his thanks to Messrs. W. & T. Avery, Ltd., Baird & Tatlock, Ltd., W. & J. George, Ltd., A. Gallenkamp & Co., Ltd., and W. Watson & Sons, Ltd., for the assistance rendered.

* The Foundry Trade Journal, Vol. 27, p. 273.

Mr. C. P. Cockrill, colliery agent and merchant, has been elected to the Mayoralty of Chester for the ensuing year.

Slight damage was done by fire at the works of Thomas O'Brien & Company, of Upper Thames Street, London, E.C.4, last week.

An Apprenticeship Course in Foundry Practice.—LXII.

By Ben Shaw and James Edgar.

THE PREPARATION OF MOULDS FOR STEEL CASTINGS.

Differences from Iron Work.

The methods of preparing moulds to receive molten steel do not differ much from those used in the making of moulds for cast iron. The average iron moulder would have little difficulty in becoming a steel moulder, providing he kept in mind the difference in temperature and the greater contraction of the steel. In the steel foundry moulding boxes are mainly used for both drag and cope. In the iron foundry a considerable amount of work is prepared in the floor, even comparatively small work, and especially is this so in jobbing foundries. This form of moulding is not by any means so common in the steel foundry. This does not mean that no moulds for steel are made in the floor, but it is not the general practice. The main reason for the difference is associated with the ramming of the moulds and the practice of casting work on end when possible.

The use of box parts enables the turn-over process to be used, and this method gives better facilities for ramming the sand to the required density than is possible by bedding-in. Sand moulds for steel require to be more tightly rammed than for iron. When the foundry floor is used for the drag, the design of the required casting is usually of such a character that the preparation of suitable boxes would either be too expensive or too unwieldy in use. The floor is used, however, particularly for large castings, such as are required for ship construction, as, for instance, stem and stern frames that are long and narrow and vary so much in design that new box parts would almost need to be prepared for each casting required. While it is for such moulds that the process of bedding in the foundry floor is used, a casting is frequently made up in the floor, not of cast iron as in the iron foundry, but of bricks. It is necessary, of course, to make up a case to suit the particular shape of each pattern, but there are considerable advantages, because there is a reduction of the area that has to be rammed and, since this type of mould needs to be dried, the bricks form a barrier between the dried mould and the damp floor sand. The surface of the bricked chamber is the level at which the joint of the mould is made.

Suitable Sands.

The mould for steel are made in green sand, dry sand and loam, as in the case of cast iron, although invariably the term "compo" is used instead of the term "loam." Compo has a similar consistency to the loam of the iron foundry, and is used and applied in a somewhat similar way. For convenience we shall speak of compo moulding as loam moulding. As has been stated in a previous article, owing to the high temperature of molten steel as compared with that of cast iron, greater care is necessary in the selection of the sand used, particularly of that sand which forms the face of the mould. It must be of high refractoriness and as free as possible from lime, magnesia or any alkalies that are likely to form silicates when raised to the temperature of the steel. A purer form of silica sand is desirable than is used for cast iron. Naturally, bonded sands are obtained in this country, although at one time we imported sand for the purpose. That known as Yorkshire sand is profitably used in both green-sand and dry-sand moulding, although other sands considered to be of equal quality have been put on the market during recent years. A good red rock sand like Doncaster sand also gives good results. With naturally-bonded sand, that is, clay-bonded sand, the quality of the floor sand is reduced owing to the clay being burnt and converted into fine dust. The continued use of the floor sand in conjunction with new for the facing sand mixture causes deterioration and makes the sand less permeable. To obviate this, one firm in particular has devised a means for blowing the burnt clay from the used sand, retaining only the silica sand. To this silica sand a definite percentage of clay is added as a bond, and the mixture is milled. By this means the same sand is used over and over again, and yet the surface on the castings is all that could be desired.

The difficulty due to the use of clay bond is not experienced to the same extent when an artificial bond is used with a silica sand low in natural bond, because the bond is burnt out in contact with the metal. Naturally-bonded sands are, however, more generally used in this country, being more economical.

"Compo" for Dry-Sand Work.

When the moulds are to be dried, the sand mixtures are somewhat similar as for green-sand moulding, but the percentage of bond needs to be greater to allow for the reduction in strength due to the removal of the moisture. For large dry-sand work, steel moulders' "compo" is incorporated with the dry-sand mixture. This consists of broken crucibles, burnt ganister from coke furnaces, hard coke and old ganister bricks ground together in various proportions, together with clay, to give the required bond. The amount of this compo, added to a high silica sand to form a dry-sand facing, varies very much according to the size of casting and its sectional thickness. The refractoriness of compo can be readily imagined from the ingredients, and when the metal thickness is considerable, the proportion of compo is relatively high. Ground with sufficient water to give it a consistency similar to loam in the iron foundry, compo is used for moulds of large size that can be swept or strickled satisfactorily, and it also forms the main material for cores that are necessary for large work. Many steel foundries prefer to make their own compo, when the mixture can be varied to suit their special requirements, but specially prepared compo is supplied to steel foundries by firms that make a speciality of refractory materials. Compo somewhat resembles fireclay, but it is much coarser. While it undoubtedly meets the need from the point of view of refractoriness, it has one important disadvantage in use. When moulds consisting of compo are dried, they possess considerable strength. We have previously referred to the comparative weakness of steel just after it has solidified, and to the fact that considerable contraction takes place while it is cooling to a normal temperature. Thus the compo, which is strong, offers so much resistance to contraction that, unless precautions are taken to weaken the mould and so enable it to be crushed by the strain of the metal, the casting will be unable to take up its true shape on cooling, with the result that a fracture is more than probable. It must be remembered that the approximate contraction for steel is 1 in. in 5 ft., and this means a considerable amount of crushing to the mould. It is, of course, frequently necessary to take special precautions for the contraction of an iron casting by weakening parts of the mould to release the strain, but these precautions are a greater necessity with steel castings. Cores that are to be practically surrounded with metal need very special care in this direction. Although compo is profitably used when dealing with large work, its use for small or even medium-sized work is not suitable, as not only is it too strong, but much time and energy is involved in cleaning the resulting castings. Either a naturally or artificially-bonded sand gives better results and causes less trouble.

Facings.

The apprentice pattern-maker should bear in mind that, whereas sweeping boards used in the iron foundry may have a woodworking edge, sweep-

ing boards used in the steel foundry are usually reinforced with sheet iron, or bar iron is screwed to the back of the board and forms the working edge. This is done because the compo is very coarse and wears wood quickly. Dry-sand and compo moulds are invariably given a facing wash. For small and medium-sized castings the wash for the moulds usually consists of graphite, bonded with china clay. Sometimes fluor silica is also added, but the former gives a good finish. For very large work, when a good surface is relatively unimportant, compo is thinned with water and a little more clay added. With green-sand moulds, when a facing is desirable, graphite is dusted and sleeked over in a manner similar to that adopted in the iron foundry, but sometimes fluor silica is mixed with the graphite. Although it is necessary to ram the sand next to the pattern as hard as possible in order to give the casting a better surface, there is no need for the same amount of venting that is required for cast iron. Venting is necessary, of course, and it is prepared for in a similar way as for cast iron, but molten steel is a very "lazy" metal when fluid, and solidifies very quickly.

Reducing Contraction Strains.

Apart from the need for weakening the formation of mould so that the strain on the cooling metal will be materially reduced, it is advisable, in many instances, to support projecting parts of the casting in order that the effect of the resistance offered by the mould is reduced. This is done by introducing thin webs connecting the parts likely to be strained by the mould with the main body. These webs resemble brackets that may be designed to support a flange to the main part of a casting, but instead of them being of similar thickness to the main body, they are usually about $\frac{1}{4}$ in. thick, but vary somewhat according to the casting thickness. Patterns are usually modified at the steel foundry and webs are added where desirable, but sometimes the moulds are made up after the pattern has been withdrawn. As a rule, however, the moulder prefers the thin webs to be set on the pattern in the first place, as the steel moulding sand is not so conveniently made up as the sand mixtures in the iron foundry. It is the thickness of these webs that give them their special value; they solidify and give off heat so rapidly that they support thicker parts that retain their heat longer because of the greater bulk of metal in them. Thus, during the most critical time, when the casting as a whole is contracting, the projecting parts that are at right-angles to the direction of the main contraction are supported by these webs, because the metal forming them has reached a lower temperature than the thicker parts; consequently it is stronger and better able to overcome the resistance of the mould.

Chills.

Changes in the metal thickness of steel castings cannot be avoided any more than with iron castings, and it is very essential to make such changes as gradual as possible, in order that the variation in the rate of contraction may likewise be gradual. An abrupt change is a source of weakness to any casting, but particularly to a steel casting. It is a common and very necessary practice, when unequal thickness cannot be avoided, to assist the cooling of the thicker parts in order that the whole may cool more regularly. For this purpose chills are in frequent use, particularly at the junction of flanges or branches with the main body of the casting, where a fillet is desirable. These metal chills are located against the pattern when a commencement is made with the mould in a manner similar to the use of denseners in the case of iron castings.

Nailing Faces and Corners.

The face of moulds for steel should be well nailed, and especially is this a necessity with medium and large-sized work. Sharp corners, when these are essential, and those areas that receive the first rush of metal from the runners, should be given special attention in this respect. These protect the surface of the mould and enable it to resist the effect of the high temperature and the rush of the metal more effectively. Steel moulders' nails are also used to chill the metal in order to reduce piping or segregation due to shrinkage. In some cases they may be located in the mould so that they will pass through the metal, but more generally they project into the mould an amount varying with the thickness of the metal section.

Considerations when Making Grids.

Grids or irons that are used to stiffen parts of a mould, and which are likely to interfere with the contraction of a casting, should be so designed that such a possibility is rendered improbable. The ends of the grids should be at least 2 to 3 in. from the faces of the moulds for large work, and in many instances it is profitable to use wrought iron instead of cast-iron dabbers or prods on the grid. The latter are rigid, and do not give to the pressure applied by the contracting metal. Wrought iron, on the other hand, offers less resistance, as it readily bends. Very special attention must be given to the grids in large cores, particularly when they will be almost surrounded by metal and are not accessible for easing after the job is cast. It is of little value weakening the core at various places with unbonded silica sand if the grid in it is constructed to offer other than slight resistance to crushing. The construction of suitable grids for moulds to receive steel demands greater foresight than those necessary for moulds in the iron foundry, although, whether for steel or iron when the work is of a complicated character, especially in the making of cores, devising suitable grids or irons demands considerable experience and skill.

Value of Fins.

As in the case of large moulds for cast iron, it is common practice to cut the joint back a bit to form a fin on the casting, but, owing to the lower fluidity of the metal, the amount cut back is usually greater. In many cases fins are an advantage, but the chief reason for cutting back joints is really to reduce the possibility of a crush when the mould is finally closed. When the fins are filled during the time of casting a job, the metal solidifies almost at once, and thus any pressure of air or gases at the joint will have little effect on the casting. To a certain extent, fins also collect dirt that is gathered from the mould as the metal rises. Some discretion is necessary in preparing the fins, as they may increase the strain on the casting when cooling.

Bottom Pouring of Metal.

With the exception of steel melted in crucibles, other steels are usually, though not always, cast from the bottom of ladles rather than from the top lips, as with cast iron. For this purpose a special stopper is employed, which is operated from the side of the ladle. This stopper is usually semi-spherical in shape, and fits into a seating at the bottom of the ladle like a valve. There are several reasons for the use of these special ladles. The metal, for instance, is very lazy in comparison with cast iron, it has low fluidity, the slag is not so easily separated from the surface, and thus slag would be more likely to run with the metal than in the case of cast iron, and, owing to the number of "jumpers" and the excessive heat which would be given off were the slag removed, top-pouring would be more dangerous than the method adopted.

Gating.

Owing to the comparatively low fluidity of steel when molten, gates are larger than would be necessary for similar work in cast iron. Cast steel solidifies quickly, and the milder the steel, the quicker it sets. It is therefore common practice, when making deep castings, to use a spray of runners from the main gate. This does not increase the speed of filling a mould, but it does supply hot metal to the surface as the mould is filling. For large work it is customary to prepare special gates that are capable of withstanding the intense heat of the metal. These are usually made from ganister and prepared to suit the job for which they are to be used. They are built into the mould during the time of ramming, straw or waste being used to plug them temporarily to prevent sand entering. On account of the high shrinkage of steel, risers or heads are usually large. These feed the casting, and assist by their pressure in removing gases.

XUM

South Staffordshire Iron and Steel Institute.

At the open meeting held last Friday, Mr. F. J. Cook, a past-President of the Institute of British Foundrymen, delivered his Presidential Address on "Research," of which the following is an abstract.

Blast Furnace Research.

It is impossible to deal extensively or even adequately within the range of a short address with such a subject as research. One of the inevitable results of investigation is almost invariably the opening up of fresh fields of inquiry, and that has been the experience in practically all branches of iron and steel investigation.

Great progress has been made during the last two or three decades, but a great deal of work needs to be done in various fields of inquiry. That is especially true of the blast furnace. We need to know a great deal more in regard to the proper relationship to each other of blast, volume, pressure and temperature, and their effects on the suffusion and diffusion throughout the product of the various elements, particularly carbon.

The economic side of the metallurgical industry is of vital importance at present, and much larger advantage ought to be taken, with a view to profitable production, of what are usually termed the by-products. Slags during the past few years have been much more largely used, especially as macadam, tarred and otherwise, for road-making, and slags also are valued as agricultural fertilisers. One beneficial effect at least has been the improvement of the landscape in various parts of the country, and especially in South Staffordshire, which one may say with confidence every year less deserves the somewhat derogatory title of "The Black Country." Most people agree that it is not so black as it is painted, and the improvement in appearance is really largely due to the practical application of recent research. Great strides have also been made in the use of blast-furnace gases, but in regard to the extraction of residuals it may safely be said that the surface has only been scratched, and much greater profit could be realised by the *control* of the by-products. Up to the present, attention has almost wholly been concentrated upon the manufacture of pig-iron. The metallurgist who uses pig-iron will be the last to complain of this, but it is now being recognised that equal attention ought to be given to the gaseous products given off in course of manufacture. For example, it should be possible to regulate the burden going into the furnace, not only with regard to the pig-iron product, but to secure the right kind of gaseous volume in order to obtain the most profitable by-products of maximum quality and quantity, and to do this without detriment to the pig-iron produced. In a word, future blast-furnace practice will aim not only to make good pig-iron, but to get the most also out of the by-products. It is quite within the range of possibility that some day not far distant the residuals will be the primary object of blast-furnace practice, and pig-iron will be considered the by-product.

The capabilities of the blast furnace as a producer of motor spirit have hardly yet been realised, but it is clear that in this direction a wide field of opportunity is gradually opening up. The modern motor-car, with its wide range of usefulness for business and pleasure, has been made possible largely through the production of high-quality steel and other metals, and it would be a kind of reciprocal justice if the motor, by utilising largely petrol or some other motive spirit produced from blast furnace by-products, should be a source of strength and profit to the iron and steel trades.

One of the compensations of the war came through the additions to our knowledge in regard to the production, among other things, of essential by-products. In this case necessity was, once more, the mother of invention. We were obliged to produce in large quantities potash for various munition requirements, and it was found that the inclusion in the blast-furnace of a certain ingredient in small quantities led to the maximum production of potash in the flue dust. To use an Americanism, that should furnish our blast-furnace chemists with a useful pointer, indicating how in the future it should be possible to control for profit-making purposes the output of the blast furnace, not only in regard to pig-iron, but in respect to the available and highly valuable by-products. By enriching the gases—which when we have learnt how to utilise—it should be possible to produce much more satisfactory balance sheets.

Research on Steel.

In recent years much specialised research has been devoted to steel, but in this department very special attention needs to be devoted to corrosion and its prevention. It is common knowledge that in regard to an ordinary so-called corrugated iron sheet—usually, by the way, made from steel—the life of the modern sheet is only about one-third that of the old-fashioned sheet made from reliable Staffordshire iron. It is most urgent that work should be done having for its object the introduction of a special steel possessing essentially durable qualities, and the ideal in view should be its production without any material addition to cost. So far, the galvanised sheet has held the field, no adequate substitute for the spelter coating having been found, but a galvanised sheet is, after all, a sort of makeshift, and the preliminary pickling in powerful acids itself introduces an element of danger, which occasionally, no doubt, helps to shorten the life of the sheet. The day ought not to be far distant when a material possessing inherently durable qualities should be placed on the market, putting an end to the expensive and unsatisfactory process of galvanising.

Iron Making.

The question of paramount importance to the members of this Association, and the large industrial community which we represent, is the question what can be done to improve the position of the Staffordshire iron trade, now passing through a period of disheartening depression. Iron-making is peculiarly a Staffordshire trade, and from this district the pioneers of the industry have gone forth to lay the foundations of progress and successful production in the greatest of the world's iron-making centres. Yet nowhere is the struggle for existence sterner than in what may be called the birthplace of the iron trade. For this, to some extent, the ironmasters of an earlier generation are not altogether free from blame. Many of us are old enough to remember the confidence with which the early steelmakers of the 'seventies and 'eighties foretold the doom of the iron trade following the advent of comparatively cheap steel. It was said that the inventions of Bessemer, Siemens, Martin and others had sounded the death-knell of the wrought-iron industry. Many of the ironmasters were foolish to take lying down, so to speak, this sentence of death for their industry, and that mood of acquiescence laid up a store of troubles for the present generation.

Thirty years' experience of steel, while it has demonstrated its virtues and the great services it is qualified to render to the world, has no less emphasised its deficiencies and limitations, with the result that, under normal conditions of consumption, the demand for first-class iron would probably be as great as at any time in the world's history. Some progress has been made in the direction of catching up with present-day requirements. A most important branch of research is that now being carried on, having for its object the elimination to the utmost possible extent of the laborious work connected with iron production. Young men do not take kindly to the drudgery of puddling, while the necessity of making iron production much less empirical than it has hitherto been is also recognised. In this research the lead is being taken by Mr. J. E. Fletcher, a past-President of this Association, for whom we all have the greatest possible respect, and he will have with him the best wishes of his colleagues for a practical and permanent result of his labours.

Much headway has also been made in the production of wrought iron direct from the ores, and members generally will be interested in knowing that this process forms the basis of a Paper to be given during the session by Mr. Goodwin. It may well be that the results of these applications of science to the iron trade may assist in placing it altogether on a more prosperous basis.

Testing Metals.

The questions of mechanical tests and standard specifications are matters attention to which is long overdue. The need for a general revision of the chemical compositions which usually appear in specifications has long been apparent. Although a great deal of investigation has been conducted with regard to the effects of the various elements in the composition of metal, it would be far too much to say that our present knowledge of metallurgical chemistry in these directions is approaching finality, or that we have studied to its ultimate conclusion the action of elements in such a way as to arrive at what may be called the stage of equilibrium in regard to their relative influence.

Revision of Specifications.

One piece of evidence showing the very unsatisfactory position with regard to this matter we are very familiar with, in the character of the specifications issued, for example, by such large buyers as railway companies, when they are placing orders for rails. These specifications allow of very wide variations, in spite of the fact that the individual company sets out its requirements within very narrow limits. The general effect as between a variety of specifications is a wide range of requirements. A peculiar circumstance also is that while narrow limits are laid down for the British manufacturer, the company, when buying from foreign countries, is quite ready to allow much wider departures from the ideals they have laid down in their specifications. The position has become altogether confused in a way which works especially to the disadvantage of, and with great unfairness to, the British manufacturer. It is well known that, in spite of all these wide divergencies in specifications, the rails give sufficiently good results in practice, in this respect comparing quite favourably with the railroad tracks of other countries. Accidents on British railways from this cause are almost unknown, and the same cannot be said for the railways of certain other foreign countries. Enough has been said to show that the present bases of chemical specifications require revision.

There is some parallel between the position in regard to these specifications and the anomalies which arose in connection with the production of war material. It is well known that very fine limits were laid down by the British authorities in regard to metals used for munitions, and some rather keen criticism was offered in regard to these by metallurgical experts whose eminence entitle them to speak with authority. The opportunities which have since arisen for the examination of material used in munitions both by our Allies and our enemies tends to show that they served the purpose in view quite as satisfactorily as the metals produced in this country, in accordance with very much more exacting specifications. It seems clear that if certain specified physical tests are met a much wider range of chemical composition might be permitted. The state of our knowledge on these matters is admittedly imperfect, and it must be recognised, after all, that if the metal meets the physical demands made upon it and proves reliable in practice, the really essential condition has been met. There appears to be too much insistence on certain theoretical ideals which after all may be based on imperfect knowledge.

Testing of Cast Iron.

With regard to cast iron, the question of testing may, without unfairness, be described as chaotic. In this connection it is reassuring to know that a suggested specification has been drawn up by a special committee of the Institute of British Foundrymen in which quite a number of our officers have taken a conspicuous part. That specification has been put forward for consideration by various other metallurgical societies in the country, and it is hoped some tangible results may accrue, enabling a standard to be set up based upon the comparative results obtained in the various works of this country and abroad.

At present the results of tests as they are usually published in connection with cast iron are too often scarcely worth the paper they are written upon, owing to the lack of standard conditions to be observed, equally in connection with manufacture and testing.

A very serious obstacle to the prosperity of the wrought-iron industry, which we all so earnestly desire to see, is the out-of-date equipment of many of the local works, aggravated in some cases by the disregard of the ordinary economics of production in the lay-out of the works themselves. The latter defect has serious consequences, particularly in the unnecessary haulage of materials or unfinished products from one department to another. From this point of view, the works in the northern part of the county show much more evidence of foresight and regard for economy, the furnaces usually being built in close proximity to the line of railway, delivering pig-iron, fuel, etc., to the works, the line also being always close at hand to receive the finished products. Some rather flagrant examples of disregard of these essentials to economic production could be cited in South Staffordshire, and whereas an earlier generation managed to thrive in spite of wasteful production, the matter has now become almost vital in the struggle for existence.

With a few notable exceptions, the district has been at a standstill for some years past in the matter of reconstruction and the modernising of plant, though it is only fair to add the principal explanation for this has been the lack of necessary capital.

Another explanation, however, has already been hinted at in the too ready acquiescence in the dictum that the eventual supremacy of steel would necessarily involve the extinction of the iron trade. It might not have been an unmixed evil if some of the German bombers had made targets of certain establishments, notoriously flagrant examples of wasteful production. In that event some national assistance might have been obtained to replace the obsolete plant with really modern and well-equipped ironworks. The manufacturers of France and Belgium will find some compensation for their industrial losses in the war through the rebuilding of works destroyed by their enemies. It may be taken for granted that in every case the most modern ideas have been embodied in the new plant installed, and some of these establishments are now among our keenest competitors.

The carrying out of much-needed improvements depends mainly upon the return to trade prosperity, and our manufacturers are hampered greatly by what has been facetiously termed "the eternal want of pence." It may be concluded that the delays in reconstruction are not due either to want of knowledge or goodwill, but behind the question of reconstruction the real key to the situation is an adequate demand. Demand usually creates supply, and if the demand existed it might be found possible, to some extent, by means of amalgamations, to provide the necessary capital for bringing the local plant much nearer to the ideal state which so many of us have in mind, and which by this time must be familiar to every well-informed manufacturer.

The trade horizon is clouded, and we find in every direction, not only in foreign countries but in our own colonies, the door is being shut, and in some cases barred, against us by the imposition of new tariffs or the increase of those already existing. In touching this aspect of the questions at issue, one is treading on somewhat dangerous and controversial ground, since economics are to some extent barred from our consideration. The fact remains, however, that unless our works are carried on at a profit, the application of applied science in the direction of improvement is impossible. Probably there is agreement on certain broad principles and general conclusions. In a great self-supporting country like the United States, with its enormous home market and its command of the requisite raw materials, it seems inevitable that the policy of tariffs must bring

prosperity by retaining the home market to the home manufacturer. Obviously, in this country the position is widely different, seeing that we are largely dependent for at least the major portion of our necessaries of life and for the requisite raw material upon foreign countries, and probably a tariff would be just as harmful to us as it appears to be beneficial to America.

If Great Britain could command anything like the same volume of orders, there is no reason why this country should not produce just as cheaply as America goods of possibly even better quality.

Increasing attention is now being very properly given to the undoubted advantages that we possess as an Empire. Within the wide circle of our dominion we have everything in the way of food and the requisite raw materials for our population and manufacture. There seems no reason, therefore, why the Empire should not be just as self-supporting as America, and on the other hand, there is every reason why we should be bonded together quite as effectively as the various states of America in one union. That necessity and that opportunity should be impressed upon all broad-minded statesmen, and should never be absent from the view of our leaders of industry. It would seem that in this direction, in the cultivation of Imperial trade and closer cohesion between the various constituents of the Empire, we must look for the recovery and maintenance of future prosperity.

Mechanical Tests of Metals.

The mechanical tests used in investigating and testing metals, and their relation to the behaviour of metals in service, to the design of metal structures, and to the behaviour of those structures, were reviewed by Dr. D. Hanson (Chairman of the London Local Section) of the Institute of Metals, at the first meeting this session. Dr. Hanson said that in using a metal we must ask what were the conditions it had to meet in service, and what were the qualities it was necessary to obtain in the metal in order to meet those requirements. That was a difficult question to answer in many cases, because conditions were so complicated that it was impossible to say in terms of simple stress what the metal had to withstand. An example of a complex case was the laminated spring for a road vehicle, which had to stand all sorts of stresses which were incalculable. In the case of a high-pressure gas cylinder, however, it was possible to estimate the stresses the metal would have to stand, and this fact had had a definite influence on design. Whereas at one time the safety factor was from 6 to 8 in such a cylinder, it was now a little over 2, or perhaps 3, of the breaking strength, and the weight was considerably reduced.

The usual method of designing a structure was very much a matter of hit or miss. As a rule the tensile strength of the material was measured, the stresses in the structure estimated, very often extremely roughly, and the section of the material was based on the tensile strength, allowing a very considerable factor of safety. The real test in such a case was actual experience, and very little else.

Examining some of the types of stress to which metals are subjected, Dr. Hanson divided them into steady stresses, fluctuating stresses, and the stress of shock. It had been stated that the most important property of metals in this question of design was the elastic limit, or the limit of proportionality, and attempts had been made to base design on measurements of the elastic limit, not always with success. He believed there was some reason for that. The elastic limit was a very elusive quality in metals, depending entirely on the sensitivity of the apparatus used for its elucidation; the more carefully we examined the metal the lower we found the elastic limit, and he had come to the conclusion that no method of determining the elastic limit by a tension test was at present reliable. Under steady stress no great damage was done if the metal was stressed up to its yield point, and therefore, for estimating the suitability of a material for withstanding steady stresses, the yield stress was the most suitable guide. Discussing the notched-bar test, he said stresses, which it was thought might be connected with the failure of certain parts of the bridge, and he understood that a report on this particular bridge was in the hands of the Institution of Mechanical Engineers. The determination of the fatigue range of a metal was not a simple matter, but it could be, and was being, done. He described a simple modification of the Wöhler test for the determination of fatigue range. The specimen was a rotating cantilever with an end load; the load was gradually increased from zero, and deflection was produced by the load. If the deflection were plotted against the load, the curve obtained would be straight up to a point, when it would be deflected, and the point at which it departed from the straight was approximately, for most materials, the fatigue range. It was a sort of elastic-limit determination on a rotating specimen.

Dealing with shock stresses, Dr. Hanson said he did not know of a single test which could be said to measure the liability of metals to fracture under shock. Ordinary static or fatigue tests offered no indication whatever. For particular cases tests had been devised, such as for the testing of railway couplings. This test aimed at imitating the conditions to which the coupling was subjected during service. The coupling was subjected to a live load of usually 5 ft.-tons in an impact-testing machine; if it stretched more than a certain amount it was rejected because it was too soft, and if it broke it was rejected because it was too brittle. It was not a test of the material, however, but a test of the coupling. The factors in the behaviour of metal under shock were different from those under steadily applied stresses; in iron, shock deformed the metal by a somewhat different process than in the case of steadily applied stresses. A material which failed from shock had, in the neighbourhood of the shock, a considerable number of Neumann lamellæ—mechanical twin crystals—which were never found after static tensile or fatigue tests. It was noticed in chains, and indicated that a chain failed very frequently under a type of stress that did not enter into any tests used to test the quality of the metal. A reliable method of determining the resistance of materials to shock would be of the greatest value to engineers.

Contracts Open.

London, S.E., October 30.—Providing, laying and fixing about 1⅛ miles of double line of cast-iron socket and spigot pipes, together with air valves, etc., for the London County Council. The Engineer at the Old County Hall, Spring Gardens, S.W.1. (Fee, £5, returnable.)

London, S.W., November 2.—(1) Steel material, and (2) wheels and axles for wagons, for the Bombay, Baroda and Central India Railway Company, 91, Petty France, Westminster, S.W.1. Mr. S. G. S. Young, secretary. (Fee, 20s., non-returnable.)

Margate, October 29.—Supply, delivery and laying of about 4,260 ft. of 12-in. and 7,740 ft. of 6-in. cast-iron water main, for the Corporation. Mr. E. A. Borg, 13, Grosvenor Place, Margate.

Karachi, November 3.—For the Karachi Municipality, India:—(1) Deep-well three-throw pumps in duplicate, with shafting, gears, etc., capacity of each unit nine million gallons per 24 hours; (2) cast-iron well linings and gauge plates; (3) steel chimney shaft; (4) travelling crane. J. Taylor & Sons, civil engineers, 36, Victoria Street, Westminster, S.W.1. (Fee, £5, returnable.)

Peterhead, October 31.—Iron, steel or reinforced concrete footbridge, for the Peterhead Community of Feuars. Mr. G. Martin Gray, clerk and factor, 2, Ross Street, Peterhead.

Mr. A. C. Johnston, of 54, Mansfield Chambers, 17, St. Ann's Square, Manchester, has been appointed to represent James & Ronald Ritchie, Limited, Acklam Foundry, Middlesbrough, for the sale of cast-iron pipes in Lancashire and the West Riding of Yorkshire.

The date and venue of the International Foundry Trades' Exhibition, 1924, are now being considered, and with a view to ascertaining the opinions of the industry, it is proposed to hold a luncheon and meeting to-day at the Birmingham Chamber of Commerce. Mr. H. Lakin-Smith is the chairman of the Exhibition Committee.

The Manufacture of Ferro-Alloys.—I.

By J. A. Holden, M.I. Brit. F.

FERRO-CHROME.

Formerly ferro-alloys, such as ferro-manganese, ferro-chrome and ferro-silicon, were reduced in the blast furnace; nowadays, except in the case of ferro-manganese and low-grade (12 per cent.) ferro-silicon, the blast furnace is rarely used, and the alloys are made by electric smelting, or where carbon-free materials are necessary, the thermit is employed.

The first essential for the successful furnace production of ferro-alloys is a source of cheap current. Generally, with the fuel costs prevailing to-day, electricity cannot be generated cheaply enough for commercial smelting in this country. There are, however, a few favoured places where power can be developed at a price low enough to permit successful working.

Dealing firstly with the production of ferro-chrome, the demand for which comes almost entirely from the steel works, for chromium (either alone or in conjunction with other elements) is an important constituent of a large variety of alloy steels. In order to produce the different types of steels, many grades of ferro-chrome are required. Actually the grading is simply a question of carbon content, and Table I gives the full series. The alloys bracketed in the upper part of Table I may be smelted directly,

Table I.—*Outlining the grading of Ferro-chrome.*

High Carbon Series.	
8 to 10% carbon, with	60% minimum cr.
6 to 8% " "	" "
4 to 6% " "	" "
Low Carbon Series.	
2 to 4% carbon, with	60% minimum cr.
2% C. maximum, "	" "
1% " "	" "
0.75% " "	" "
0.65% " "	" "
Carbon free (made by the Thermit process).	

although this procedure may not always be the most economical. It may be better to smelt with an excess of carbon, and thus obtain an alloy very rich in carbon, and then refine in a second operation to secure a lower carbon content. If either the 4 to 6 per cent. or 6 to 8 per cent. carbon grade is made direct, the furnace slag will certainly contain appreciable percentages of chromic oxide. The most economic method thus becomes a question of arithmetic, whether the cost of power, plus labour, electrodes, etc., for the additional refining is less than the value of chromic oxide which would be wasted by simple reduction with the minimum carbon content. Unless the extra power used costs little or nothing, and the ore is costly, it is preferable to use the simpler process of smelting the grade in one operation.

Nature of Ores Used.

The ores used are mined in different parts of the world. They vary both in chemical composition and in physical properties; Rhodesian ore, for example, is more refractory than New Caledonian. As already emphasised, the consumption of electrical energy is the most important item in the cost of production; thus the refractory nature of certain ores may render their economic working an impossibility. Rhodesian ores are used in considerable quantities, and though they require more current for reduction than the New Caledonian, the high freightage on the latter renders them costly.

Table II.—*Composition of Chromium Ores.*

	Rhodesian Chromite.	Indian Chromite.	New Caledonian Chromite.	Rhodesian Chromite, very high grade.
Chromic Oxide..	46 to 54	47.01	53.9	54.11
Ferrous & Ferric Oxide* ..	10 to 14	20.75	16.0	13.80
Silica	4 to 9	3.95	1.4	—
Alumina ..	12 to 20	22.13	14.71	—
Magnesia ..	9 to 14	3.83	11.33	—

* Calculated to FeO.

Table II gives a series of analyses of various ores; column 1 gives the variations in the different constituents of Rhodesian ore. The figures are taken from twenty analyses representing thousands of tons of the material.

As the analyses show Indian chromite is not very rich in chromic oxide; it may, however, be used mixed with richer ores.

There are other sources of chromite. Small quantities of ore are mined in the Shetland Islands, and chromite from Baluchistan is shipped to Europe. The bulk, however, comes from Rhodesia and New Caledonia.

Smelting Plant.

For smelting, arc type furnaces built on the Héroult principle are commonly used. They consist of fixed rectangular furnaces with the three electrodes suspended in a line. Either open top or part-roofing is used. Amorphous carbon electrodes are used hung in split water-cooled holders, equipped with motor-driven gear for lowering and raising, together with Thury (automatic) regulator control. The voltage between phases for the high carbon alloy smelting is, as a rule, from 100 to 110. It is, however, convenient to be able to use a higher voltage when the furnace is working with a heavy slag covering. A furnace running with 8,000 to 9,000 ampères per phase, equipped with 20-in. amorphous carbon electrodes, if properly designed, and provided with modern mechanical haulage for bringing up the charges, and adequate appliances for dealing with the cast pigs of ferro-chrome, will turn out 33 tons per (seven-day) week, of an alloy containing about 60 per cent. of chromium and 6 per cent. of carbon.

The percentage recovery will amount to about 85 per cent. of chromium. The electrode consumption varies considerably. Although the breakages, as a rule, are not so high as in steel furnaces, continuous joining cannot be employed, so there is always wastage with stub ends. With good electrodes the amount used should not exceed 280 lbs. per ton of alloy cast. The Soderberg system of electrode manufacture over the furnace has proved remarkably successful, and there is no doubt that its use will increase.

The current consumed in smelting will depend upon the richness of the ore and the nature of the gangue. Smelting high-grade Rhodesian the figure will average about 7,500 kw. hrs. per ton of 60 per cent. Cr, and with carbon about 6 per cent. New Caledonian ore (which is less refractory than Rhodesian) will not require quite so much power, and a figure of 6,500 kw. hrs. can be obtained.

Either anthracite or coke breeze is used for the reducing agent. As the latter is generally cheaper it is often employed. A ferro-chrome of the grade under consideration requires 8 to 9 cwts. per ton of alloy made. As the steel maker cannot always tolerate a high silicon content, basic slags are necessary, and lime to the extent of 3 cwts. per ton of alloy will be consumed. High silicon content makes the high-carbon ferro-chrome much softer, and renders them more easily crushed. If silicon is not an objectionable constituent, it is preferable to allow it to run up to 2 per cent., and thus save considerably on the crushing costs.

Making Low-Carbon Ferro-Chrome.

To prepare the alloys in the low-carbon series, it is necessary to refine high-carbon ferro-chrome. As the refining operation practically amounts to elimination of carbon by re-action with ferrous-oxide and a consequent dilution of the chromium, the first essential is high chrome content in the primary alloy.

The primary alloy crushed to pass through a 1 in. riddle is smelted with a rich calcined chromite. The type of furnace used in the different works is considered to be somewhat secret. The

fact is, however, it is not so much a question of furnace type as a problem in metallurgical skill. In some works a furnace after the Girod type is used, *i.e.*, with a water-cooled bottom connection and a single top electrode. It is thus a single-phase furnace. The working lining consists of refractory chromite.

Unless the electrodes are of excellent quality it is practically impossible to secure very low carbon in the refined ferro-chrome. Splintering and spalling are fatal; for this reason all new batches of electrodes are preferably tried in other furnaces. As the operation is slow, current consumption figures largely on the cost sheet, and it is by no means unusual to use 5,000 kw. hrs. per ton of refined alloy.

During refining the calcined ore is fed in, followed by the alloy. As the operation proceeds, the ferrous oxide in the slag is gradually reduced: simultaneously the carbon is oxidised from the bath and the chromium content diluted. The slag from the furnaces is practically free from iron oxide, and as it is very rich in chromic oxide it constitutes a valuable by-product.

To secure saleable, low-carbon ferro-chrome it must contain a minimum of 60 per cent. chromium, and this is one of the difficulties the manufacturer has to surmount. A primary alloy is therefore selected with the chromium above 65 per cent.—preferably as high as 68 to 70 per cent. It has been stated that rich chromite is necessary. Richness of ore implies a high content of chromic oxide (Cr_2O_3); but this alone is not sufficient, for in refining practically all the iron is reduced. Thus it will be inferred that the iron oxide percentage is a matter of importance, and it explains why some ores are of very little value to the ferro-chrome maker. Thus Indian chromite is useless for refining, for it contains 12 to 13 per cent. of iron.

During refining samples are withdrawn until the metal breaks with a large open (massively crystalline) fracture. The furnace is then tapped. The final grading is done after an analysis has been made of crushed sampled pig.

The crushing of ferro-chrome is a difficult and sometimes costly item; ordinary manganese steel jaws, for example, are useless for the tough low-carbon alloys. The best steel for the crusher jaws is a high-carbon chrome-nickel toughened with molybdenum, made to the following composition:— Carbon, 0.45; manganese, 0.40; chromium, 1.20; nickel, 4.30; and molybdenum, 0.25. per cent. This steel is heat treated by air-hardening from 800 deg. C.

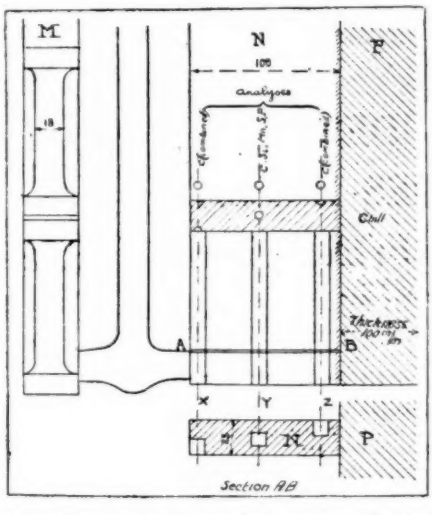
[This article recalls to mind an interesting experiment which Mr. Victor Stobie, of Dunston-on-Tyne, carried out before the war. Market conditions were favourable for buying high-carbon or cheap ferro-chrome and refining it to produce the low-carbon or expensive variety. The experiment was reasonably successful, with the exception that the cake of low-carbon ferro-chrome resisted all attempts to break it. As we believe this cake, which is 2 to 4 ins. thick and 2 ft. wide by 4 ft. long, still exists, it would be interesting if Mr. Holden could suggest some means of reducing it to usable form. Ferro-chromium is largely used by roll makers, where it improves the chill. The presence of chromium is said to be deleterious in malleable castings.—EDITOR.]

A Review of the Methods of Testing Cast Iron.*

By M. LEDESERT.

It has often been recognised that the methods for controlling cast irons now in force suffer from many serious defects. At times they may lead to the rejection of batches of castings of excellent quality, whilst on other occasions castings are passed when really below the desired standard. For this reason certain scientists have endeavoured to find methods more practical and also more exact. But the foundryman alone can confirm the value of these suggested methods, because he can put them into practice over a large number of casts with iron of different qualities. The following methods are in use, or have been proposed: ball hardness test, impact test, shear test, transverse test on small bars (Fremont), etc. Investigations have been carried out on all these methods but, so far, the results have not been co-ordinated nor is there sufficient evidence to show which should be rejected and which retained. A programme for an investigation which will correct this deficiency has been drawn up in accordance with the following conditions:—(1) It is essential that the test pieces be taken from the actual castings themselves. (2) They must be comparable, but it is well known that test pieces taken from different parts of the same casting will give very diverse results, as for instance samples from walls of different thickness or at different depths from the surface. It becomes necessary then to take test pieces under similar conditions.

From these two principles it is recommended that the test piece should be of rectangular section 1 by 4 in., coming from the foundry with the casting it is to represent and attached to the heaviest section thereof by one of its small faces, the opposite face being in contact with a chill of a predetermined thickness. After casting and knocking out the test piece is detached and divided into three sections, adjacent to the casting, the middle of its length, and adjacent to the chill. It is considered that the mean of these three results will be truly representative of the



quality of the metal. In order to verify this hypothesis, and at the same time select the best methods of testing the following series of experiments was made. Bars were cast on each side, and at an equal distance from the gate; first a round bar (M), 40 mm. dia. (1 9/16 in.), from which two tensile tests were made; second, the plate N, the outer edge of which was in contact with the chill P; from this plate the following test pieces were taken: (1) Three pieces for impact test, (2) three pieces for Fremont transverse test, (3) three ball hardness tests, (4) three pieces for chemical analysis, of which the middle one would be a complete analysis, and the remaining two tested for total carbon and combined carbon. It is important to measure casting temperature of the iron. The distribution of the test pieces should be, "X" as near as possible to the incoming metal, "Z" as near as possible to the area affected by the chill. "Y" midway between the other two. The mean of all the results would be considered as characteristic of the whole. Such a series of tests would be carried out on a number of irons of different qualities commonly employed: phosphoric iron, hematite, for ingot moulds, mottled irons for rolls: in the last case the depth of chill would be noted. From the results of a large number of such tests curves could be plotted and tables prepared which would define the value of each type of test.

*Translated from a Paper presented to the Paris International Foundry Congress.

THE FERRY COMPANY, of Sydney, Australia, have placed an order with Hawthorns & Company, Limited Leith, for the building of a fast and powerful ferry steamer, of the double-ended type, for vehicular traffic.

Institute of British Foundrymen.

LANCASHIRE BRANCH.

The opening meeting of the Lancashire Branch of the Institute was held on Saturday, October 6, at the Municipal College of Technology, Manchester.

In introducing to the members the new Branch President, Mr. R. A. Miles, Mr. J. Haigh (Past Branch President) said the members were already aware of Mr. Miles' qualifications for the post he was to fill. He had a long experience of work in the foundry, and though he had now forsaken that for the commercial side of the industry he retained his deep interest in everything connected with the foundry, and would give prompt assistance to any member who found his problems too difficult to solve unaided.

Mr. Miles took the chair, and delivered his Presidential address.

Presidential Address.

Mr. Haigh and Gentlemen,—

I deeply appreciate the confidence you have reposed in me in asking me to become your President for the session 1923-24.

I feel it is an honour, not only because of the high office, but because the position carries behind it, your faith, your belief, and your appreciation for the little that I have done for the Institute of British Foundrymen and especially the Lancashire Branch.

I would just like briefly to review our last session. Our numbers have been increased in every class of membership, and I am pleased to note that we have recently admitted the sons of three of our most prominent members. I refer to the sons of Messrs. Masters, Meadowcroft and Demain.

There have been a few resignations, brought about mainly by the persistent slump in engineering and allied trades.

I think you will all agree with me when I say how much we regret that owing to serious illness Mr. W. H. Cook, of Heaton Chapel, has been compelled to resign from his many offices, and I also regret to mention that during the year we lost, by death, a very respected member of the Burnley section—Mr. Herbert Harling.

There is, however, a brighter side, for we have had two transfers during the session, both of considerable importance, in the persons of Mr. J. S. G. Primrose from the London Branch and Mr. G. C. Grant from Newcastle, and I trust both these gentlemen will accept from me the hearty welcome of the members of the Lancashire Branch.

There are still large numbers of excellent foundrymen in this area who, for some reason, stay outside the Institute, and with a view to increasing our membership your Council have decided to hold a propaganda meeting at Wigan on Saturday, October 27, 1923, in the Mining and Technical College, at 7 p.m., when one of the Vice-Presidents, Mr. S. G. Smith, will read a Paper on "The Manufacture and Characteristics of Cast Iron."

It ought to be the aim of members to secure at least one additional member during the session, and I suggest that a personal note or a telephone message may constitute a suitable method.

The syllabus for the session is now published, and I want to assure you that your Branch Council and the Council of the Burnley section have left no stone unturned in their endeavours to provide Papers which will be of great interest and service, and in this respect no one has worked harder than Mr. Makemson, the honorary secretary.

I am not going to weary you with any long reference to the apprentice question, which I think has been dealt with sufficiently in recent Papers, but would remind you that the problem is still of great importance and is yet without solution.

The past session is one that will go down in the history of the Branch as being notable for several outstanding features—first, the President of the parent body, Mr. Oliver Stubbs, is a local member, and then Mr. Sherburn, the first President of the Branch, has been awarded the Oliver Stubbs medal. Finally, there has been the visit of the American Foundrymen's Association.

The first International Foundrymen's Congress has just been held in Paris, and when I tell you that, including more than 100 from this country and about 16 from this Branch, more than 700 foundrymen attended, representing some 14 nations, you will see that our aims are being broadcast for the common good.

The American delegation who recently visited this country on their way to the Continent paid striking tributes at various gatherings to the wonderful energy and personality of the President, Mr. Stubbs, whom they hold responsible for the successful result of the International Congress, and I am pleased to be able to inform you that Mr. Stubbs was the recipient at the hands of the French Minister of Education of a gold medal, suitably inscribed, commemorating the event.

The social side of the Branch is worth cultivating. I am sorry to say that all we see of some members is when they attend our monthly meetings. We ought to know each other better, and with this object in view I want to call attention to a social evening, which this session will be held in February instead of January at the Grand Hotel, Aytoun Street, Manchester, where we hope to have the pleasure of meeting members and their ladies, for we have decided on this occasion that the company shall be a mixed one.

I would like to mention that the annual conference this session will be held in Newcastle-upon-Tyne, and I hope that, as usual, Lancashire will be well represented.

The first quarterly "Bureau Bulletin of the British Cast-Iron Research Association" has just been issued, and is full of very excellent deliberations by well-known foundrymen, many of whom I am pleased to note are members of our Institute. It is quite evident that the labours of the British Cast-Iron Research Association have already been considerable, but there must be many more scientific and practical problems waiting to be solved, for foundrymen know that each day brings forth some new difficulty.

Several members of the Branch have been engaged for many months studying all forms of test bars with a view to standardising test bars the world over. I believe their deliberations are now complete, and as the committee is a National one it is to be hoped that a majority report will be accepted by the authorities interested.

Vote of Thanks.

Mr. S. G. Smith, in moving a vote of thanks to the President for his address, said the points which had been touched upon gave matter for serious reflection. The apprenticeship question was most important. Personally, he had endeavoured to do something towards working out a solution, but it was hard, uphill work. However, this was not an occasion on which to deal with those subjects.

Mr. J. S. G. Primrose seconded the motion. He remarked that he was specially named in the address, and he was glad to have the opportunity of assuring the members of his earnest desire to assist in carrying on the work of the Branch.

The motion was passed unanimously.

BIRMINGHAM BRANCH.

The first meeting of the session was held on Thursday night, October 11, at the Chamber of Commerce, New Street, Birmingham, the President (Mr. J. B. Johnson) in the chair.

The President having expressed a hope that the room in which they were meeting would be found more comfortable than the old quarters and that the altered time and place of meeting would give satisfaction to all the members, called upon Mr. W. T. Evans, of Derby, to open a discussion on "Oil Sand Cores."

Mr. Evans explained that he proposed to deal with the subject under the following headings:—Sands used, binders, methods of mixing, drying and driers, methods and reasons for using oil-sand cores.

Sands Used.

There are many mixtures of sand used, and each foundryman seems to have his own particular favourite which is no doubt suitable for the work in hand. Obviously some would be mentioned which are not suitable for all classes of castings; it has to be left to the individual to choose the most suitable.

There was no reason for drying sea sand, which everyone is familiar. This can be used wet or dry. Mixtures of sea sand with the ordinary red or new moulding sand of the locality are used, preferably after both sands have been dried to get an even mixture. Sand from the fettling shops, old cores which are gathered up in the foundry and reground, are the classes of mixture with which he was most familiar.

There was no reason for drying sea-sand, which is used with linseed oil and water, but the other sands are better dried before mixing, as this shortens the period of time in the core ovens.

It is not intended to say much about binders; there are now so many on the market, of which some are quite good, but there are few which are an improvement on linseed oil by itself or with molasses. Personally, he had had very little experience with the proprietary binders.

There are several mixing machines which are suitable, those similar to machines used for dough mixing being most familiar.

The ordinary machine used for mixing and aerating facing sands, either vertical or horizontal, with the double cage, is thought to be the best. The chief difficulty with this class of mixer is that the pegs in the cages get clogged with the binder. The best method of dealing with this is to dismantle the machine periodically and sand-blast the cages, which quickly cleans the sticky mess from the pegs.

The machine he had used chiefly for mixing is one with a half-round bottom like a basin with a centre shaft on which is keyed a casting carrying a series of round or square pegs. The worst feature is its simplicity. It will turn out a new mix every five minutes, the quantity obviously varying with the size. It is cheap to drive and costs very little for repairs, and empties itself into barrow, etc.

Drying Sand Cores.

The chief feature of drying oil-sand cores is that they do not require the temperature used for ordinary sand cores, which implies that many more cores can be produced from the same core ovens. Additionally, when dry, they can be handled without fear of breaking. They are more or less impervious to moisture and can be safely left in moulds for much longer periods than ordinary cores, and can be stored for indefinite periods.

For the successful production of this class of core, "driers" are absolutely necessary, as the worst feature of some mixtures of sand is that the cores are so easily distorted and broken before drying, and provision has to be made for carrying cores which are not flat by making plates or "sand driers" of the same contour as the cores. This is a matter of experience, and when carried out successfully, first-class cores true to shape are made.

Necessity for Varying Sand Mixtures.

First, as to the ordinary undried sea sand, if this is mixed with linseed oil, emulsified with water, it is suitable for most cores, but chiefly those for light castings; also, such cores as have good "driers" retain their shape, for this class of sand mixture has practically no bond when green and the least touch is sufficient to break a core, and cores cannot be made true to shape unless some special methods are adopted. This mixture is free venting and easily rammed; in fact, it only needs pressing in the boxes with the fingers, but some core-irons or wire are necessary.

To overcome this lack of bond when green, the use of mixtures containing red or other moulding sands up to 50 per cent. are successful. This class of sand can be used with very few core-irons, and in many cases core-irons are unnecessary.

It is better to dry all sand used in this mixture; also to increase the moulding sand the heavier the castings for which the cores are required.

This class of sand will require more binder in proportion to the moulding sand used, and it also requires more ramming. Where cores are under pressure at the bottom of the moulds, there should be no soft places in the cores, but they should be evenly rammed.

This mixture is suitable for relatively heavy castings, such as locomotive, gas and oil engine cores, as it will leave a clean face on the castings. It is easily removed and, being used with few or no core-irons, though rather expensive in the quantity of binder used, it will pay for itself ultimately.

The chief reason for adding red sand to sea-sand is to overcome the risk of distortion and the use of "driers," which are an expensive item for large cores. Additionally, it obviates the use of core-irons and, in most cases, where this mixture is used, cores will have sufficient bond to hold up when green and keep their shape with the minimum of support. Another feature is that cores made with sea sand alone cannot, in many cases, be successfully mended, whereas, when an addition of moulding sand is made, they can be patched up without much trouble. These cores, when dry, will be very hard, and will stand somewhat rough usage. The skin is exceptionally smooth, and there is not the rough finish on the inside of the castings that is often found with ordinary sea sand.

Another feature which recommends this mixture is that, where loose pieces have to be withdrawn, they will leave without much fear of rough edges, which are not conducive to clean castings.

A good mixture can be made from the dry sand from the fettling shop, which is quite good for light castings, such as small piston heads, etc., or any core which has not to be chapleted, for this mixture will not be strong enough to use without supports or core-irons. All old cores should be collected and returned to core-shop and reground for further use. This makes a core a little stronger than that from the fettling shop sand, and is very useful, and economical, as it uses otherwise waste material. From experience, he felt sure that foundrymen could not produce the intricate cored castings, such as motor cylinders, now called for in large quantities, without using cores made by methods under discussion. There are many snags to overcome by foundrymen commencing to use this type of material.

One great drawback is that, with some binders, there are large quantities of noxious fumes from the cores when casting, and good ventilation is essential. There would be a market for a binder at a price which would overcome to some extent this trouble.

"Driers" made from Sand.

The Branch-President said that, going through some of the local foundries recently with the American visitors, he noticed that at one foundry they had adopted a splendid idea for "driers" or plates to hold the cores when they were in the stove and to prevent distortion. They appeared to have made a sand mould of the bottom end of the core box, which they used over and over again. It was made out of waste sand and broken cores ground up, with the addition of extra linseed oil, and these "driers" were as hard as a brick, and no doubt would last a long time.

Mr. F. Dubberley said he had had over ten years' experience with sea-sand, and he found it was little use explaining its peculiarities to those who were to use it. They had to be found out from actual practice. So far as linseed oil and red sand were concerned, he had never been impressed by their use. It was a cheap method and a quick method, because there was no ramming, but they had to put up with scabs and dirt.

Mr. H. Field said that, in considering whether oil-sand cores were or were not difficult things to make, everything depended upon whether they had standardised processes. Where did the difficulties arise? If they were making their cores from sea-sand, they could not ask for a more uniform material than that. It did not vary anything like so much as red sand, although the latter always came from the same bed. As to the mixing of the sand with the oil, he admitted that they were far from being standardised In mix-

ing sand with oil, it was necessary, if they were to get an effective bond, that every particle of the sand should be coated. It was not sufficient that the materials should be roughly mixed up. As to the drying, there was only one correct temperature, and any variation causes trouble. He agreed that the market was being flooded with core oils. There was a rush of people on the market to-day selling core oils, who thought it was as easy to manufacture and sell core oil as to deal in coal or foundry shovels. These people were not supplying oils which were suitable for making high-class cores.

Mixing Considerations.

Mr. A. J. Marks thought it was essential to look at the scientific principles underlying the process in order to get rid of the difficulties to which reference had been made. There were two practical points which had a scientific basis. The first was the mixing. In mixing a substance like oil, which was usually of high viscosity compared with water, it was necessary to bring each particle of the sand in contact, because the capillary force between the particles of sand was not of so high an order as in the case of water and sand. Any machine for mixing sand, therefore, must have a rubbing action. Machines such as dough mixers, where they were using very different material, were essentially different in principle from machines which would be successful for oil-sand mixing. Any machine which was simply flapping about, or mixing by means of a fork or arm, was producing comparatively little rubbing action, so that that type of machine would be scientifically inefficient in mixing oil and sand. They wanted a machine which would cause the sand to be rubbed. As to the oil itself, the process was essentially one of oxidation brought about by heat. For using the minimum amount of oil it was necessary to balance the temperature with the available supply of oxygen. In purchasing oil for foundry work, it was essential to avoid the purchase of pure hydrocarbon oil, which would require some admixture such as molasses to bind up the particles of sand. In essence, such oils were not core oils at all. They must obtain vegetable or oxidisable oils in order to produce a satisfactory core without undue loss.

Mr. H. Tyson said he was sorry for any core-shop foreman who had to handle oils, because he never knew when he was going to get two barrels alike. The remark applied both to linseed oil and molasses. A man went along well for a time, and then his cores went wrong, there being no doubt the failure was due to the chemical properties of the different oils supplied. As to sea-sand, he considered it was necessary to dry it. His practice was to mix the sand in an ordinary sand mill, which, he thought, was almost as quick as any other mixer on the market.

A member stated that his firm tested oil at the working temperature of the core oven. A weighed sample was placed in the oven and heated for a definite period. It might vary from four to six hours. They placed the sample in a steel oven which could be maintained at a fairly constant temperature, and heated it for a stated time, afterwards weighing the residue. They must not burn the oil. It was purely by experiment that they found that the amount of residue had a considerable influence upon the stability of the cores.

Mr. H. Field suggested as a rough test that, if an oil when spread in a thin layer on glass did not go "gummy" within twenty-four hours it could be discharded without troubling to make cores with it. The test gives more information when compared with linseed oil similarly treated.

Replying upon the discussion, Mr. Evans referred to the mixing of linseed oil and water, and said it was desirable to take a square tank to hold two or three gallons, and to put in the amount of oil and water they required and turn compressed air on to it. They could see when it was emulsified, and the method was quite successful. As to drying sea-sand, he said he could not see why the sand should be dried when they were using linseed oil and water. A double-cage mixer was very successful. The speed of mixing was always the same with that type of mixer, and there was no doubt it did its work thoroughly. With regard to the different classes of oils, this was certainly a difficulty where there was no laboratory. In the case of linseed oils, where the foundryman had no one to look after the matter, he advised the use of boiled linseed oil. All his cores were dried at a temperature of about 255 deg. Fah. The question of oils containing hydrocarbons had been mentioned, and he confirmed that he was in favour of using vegetable oils.

Proposing a vote of thanks to Mr. Evans, Mr. T. Vickers mentioned that the Cast Iron Research Association was investigating oil-sand cores, and some months ago commenced the investigation of all the literature up to the time previous to the first core-making machine. They could find no mention of any stabilising of mixing of oil and water or oil and sand. He thought Mr. Evans would have enlightened them. He wondered why it was that the experts who told them all about oil-sand cores studiously avoided letting out the secret. He disagreed with Mr. Evans that the tank should be covered. It should be an open tank filled two-thirds with oil and water in the proportion of one-third of oil to two-thirds of water The air pipe should be six inches from the bottom, and just before the mixture was required the air should be turned on and kept going until the top third of the tank was filled with foam. That system gave a very great saving in the use of the oil, but best of all, it made a thorough mixture of the oil with the water and with the sand.

Mr. Tyson seconded the motion, which was heartily endorsed by the meeting.

In closing the meeting, the President appealed to those present to make known to their fellow foundrymen the advantages they would derive from becoming members of the Institute. He did not think it could be considered at all satisfactory that, in a city and district like Birmingham and its surroundings, they should be satisfied with about 180 members, and, as far as his experience went, during the past three or four years, he was afraid a great many of those were not active members. The average attendance at the meetings was about fifty or sixty. He hoped that by a combined effort during the current session it would be possible to remedy these defects. He referred to the recent visit of the American foundrymen, remarking that those who were privileged to spend a day or two with the visitors would look upon them as red letter days. He mentioned that a letter had been received from one of the visitors, Mr. C. E. Bell, expressing to the Birmingham Branch thanks and appreciation of many acts of courtesy and kindness while in the city.

Chain Screens for Furnace Doors.—Chain screens for furnaces consist of a number of separate chains hanging from a suitable supporting bar, forming a curtain, and not unlike the familiar Japanese portière. This curtain, hung before an oven or furnace opening, effectively hinders the cold air on the outside from entering the furnace and chilling the contents, and prevents the heat and glare from the furnace to the discomfort of the workmen. The loosely-hanging strands of chain are parted and pressed aside by the tools or charge when projected into the furnace, only to fall together again and close the opening when entrance has been effected. The openings in the chain permit a clear view of the interior, and the attendants can work up to within a few inches of the fire without discomfort. Such chain screens have been much used on automatic continuous furnaces, where the charge is irregularly arriving and departing on a conveyor. In such cases it is costly to keep men at the two ends to open and close the ordinary doors. Where the charge carried on the conveyor has projections that might catch in the links of the chain, the lower portion of the screen is formed of a section of tubing. These chain doors have been used in a number of plants using gas in the manufacture of steel products, notably drop forgings, rails, sheet and plate, tubes, etc., also glass and chemical works. They have also been employed on a number of coke ovens where they are known as "pusher screens." One supplied lately was for the Tata Iron & Steel Company, of Jamshedpur, India, which screens were 43 in. wide by 120 in. high. The chain doors are usually fastened to the bottom of the ordinary vertically sliding door, which the chain door replaces, when the former is raised.

Trade Talk.

THE IMPORTS of foreign iron ore at the Senhouse Dock at Maryport last week amounted to 3,500 tons.

THE QUARTERLY ASCERTAINMENT in the pig-iron trade of Staffordshire and Northamptonshire gives blast-furnacemen an advance of 1¾ per cent. in their wages down to January.

E. A. HERBERT & COMPANY, iron and steel merchants, etc., of 104, High Holborn, London, W.C.1, have been appointed agents for the Swiss Aluminium Rolling Mills Trading Association.

AN EXPLOSION took place at Whittaker's foundry at Church, Accrington, on October 11, one of the proprietors, Mr. E. Whittaker, being severely injured. Only slight damage was done to the premises.

THE STAVELEY COAL & IRON COMPANY, LIMITED, Chesterfield, have recently added to their already numerous list of activities the lining of cast-iron pipes with concrete. An order has been received by them from the Chesterfield Corporation for a quantity of these pipes.

A MINING SOCIETY has been formed to serve the interests of the mining community surrounding Normanton and Castleford, one of the objects of the organisation being the forwarding of the "Safety in Mines" movement. The officers elected for the first year are:—Mr. W. D. Lloyd, of Altofts, president; Mr. R. J. Shaw, Whitwood, Mr. J. W. McTrusty, Featherstone, and Mr. Roberts, Sharlston, vice-presidents; Mr. G. A. Jackson, Altofts, general secretary, and Mr. F. W. Milsom, Castleford, treasurer.

THE ANNUAL REPORT of the Midland Counties Institution of Engineers shows that the membership on July 31 was 329, compared with 336 for the previous year. The income for the year amounted to £955, and the expenditure to £1,064. Several meetings have been held during the year for the discussion of papers, and the following have been read:—"Presidential Address," by Sir Charles Seely, Bart.; "The Devastated Coalfields of Northern France," by Lt.-Col. F. I. Leslie Ditmas; "Leakage Protection for a Direct-current Installation," by Mr. N. E. Webster.

A SUBSTANTIAL ORDER for water turbines has just been received by Vickers, Limited (Hydro-Electric Department), from the City of Winnipeg, Canada. These turbines are for extension to the power station at Point du Bois on the Winnipeg River, but they are of much larger capacity than the turbines already installed. Three units have been ordered, each of 7,300 h.p., the head being 45 ft. Over 750 tons of water turbines have been shipped to India and New Zealand from Messrs. Vickers' shops since June of this year.

SIR WILLIAM MACKENZIE, K.C., sat as arbiter in Glasgow in a difference which had arisen in the light castings industry in the Falkirk district. The question was whether the rate of pay for daysmen moulders should be what the unions maintained was the Scottish standard rate of 1s. 1½d. per hour, plus 11s. 6d. per week war bonus, being an all-in rate of 64s. 4½d. per week. Mr. W. R. Blair and Mr. J. King, on behalf of the National Light Castings Ironfounders' Federation, maintained that in 1920 the minimum rate was fixed at 98s. a week, that that rate had been reduced in instalments by agreement to the present rate of 61s. 7½d. per week, and that those agreements are still in force. The decision will be given shortly.

THE PROPOSED ACQUISITION by Richard Thomas & Company, Limited, of the business of the Grovesend Steel & Tinplate Company, Limited, has been approved by the shareholders of the latter company. The Grovesend shareholders are to get 375,000 ordinary shares in Richard Thomas & Company, these shares being of £1 denomination, and in addition they get in cash £725,000, the shares and cash being for their 500,000 Grovesend shares. The total purchase price, therefore, is £1,100,000, which covers the whole of the ordinary shares of the Grovesend Company. The purchasers are to take over the whole of the Grovesend undertaking, including profits as from the date given for the handing over, this being March 31. It is probable that the directors of Richard Thomas & Company will call their shareholders together prior to that date.

RANSOMES & RAPIER, LIMITED, of Ipswich, are now carrying out an order for two large cranes for the North-Western Railway of India. These cranes, one of which has just been completed, are steam travelling bridge-erecting cranes, of breakdown type, with a specified lifting capacity of 25 tons. By invitation of the company a large number of members of the Ipswich Engineering Society visited the Waterside Works to witness a test of the crane. The president of the Society (Lieut.-Col. P. D. Ionides) was amongst those present. Mr. A. E. Newby, works manager, gave an interesting description of the crane, which he said was for use on the North-West Railway of India for putting in place girders in connection with their new bridge scheme. It will probably be ultimately used as a steam breakdown crane on special duties. It weighs about 135 tons, the weight being equally distributed over eight axles. It is over 50 ft. in length, and the length of the jib is 47 ft. By an ingenious arrangement the crane can be propped up on eight girders (four on each side), which in a few minutes can be drawn out from beneath the platform, to take the weight off the bogies. A test load of 32 tons was lifted at 25 ft. radius, and slewed in both directions. The crane was then unpropped, and 24 tons was lifted at 20 ft. radius, and the crane travelled with this load in various positions. The load was then discarded, and the crane was made ready for travelling at high speed as part of a train. For this purpose the jib was lowered to a horizontal position.

Personal.

PROFESSOR F. C. LEA has been appointed to the Chair of Mechanical Engineering at the University of Sheffield, in succession to Emeritus Professor Ripper.

MR. E. J. WILEY, manager of James Wiley & Sons, Limited, nut and bolt manufacturers, Darlaston, is the new president of the Wednesbury Engineering Society.

MR. G. DAWSON, goods agent for the Great Central Railway Company at Leicester for the past two years, has been appointed to the chief goods agency at Sheffield (L. & N.E.R.).

MR. GEORGE F. DOWNS, formerly president of the Lackawanna Steel Company, has joined the board of the British Empire Steel Corporation as a director and member of the executive committee.

MR. H. WINTERTON, who is well known in technical foundry circles, having on many occasions read papers on Foundry Refractractories, has been appointed chairman of directors by his firm, Messrs. William Cummings & Company, Limited, of Kelvinvale Mills, Maryhill, Glasgow.

COLONEL D. H. MCDOUGALL has resigned his post as vice-president of the British Empire Steel Corporation, and is about to start a private practice as a consulting engineer with offices in Montreal, New York and Vancouver. Mr. McDougall will retain his seat on the board of directors. Mr. McDougall has been associated with the companies now forming the British Empire Steel Corporation for the past twenty years.

Obituary.

MR. FREDERICK TYZACK died on Tuesday at his residence, Psalter House, Brincliffe, Psalter Lane, Sheffield, after a short illness. He was 74 years of age, but up to a few years ago was attending business regularly at W. Tyzack, Sons & Turner, Limited, Little London Works, of which company he had been chairman since 1906.

SIR EDMUND NUTTALL, a well-known civil engineer, died suddenly at his home at Bowden, Manchester, last week. The deceased, who was made a baronet last year for services to the nation, was head of the firm of Edmund Nuttall, Sons & Company, Limited, civil engineers and contractors, Trafford Park, Manchester. They constructed one section of the Manchester Ship Canal, and had contracted for many engineering works of the greatest importance, including railways, docks and waterworks schemes.

DR. JOHN ALLEN HARKER, who has died at Highgate, was a Dalton Chemical Scholar and Berkeley Fellow in Physics of the Owens College, Manchester, and a Joule student of the Royal Society. During the war he was Director of Research to the Ministry of Munitions, and member and organiser of the Nitrogen Products Committee, supervising the Ministry's laboratories from 1916 to 1920. In 1922 he became a partner in the firm of J. F. Crowley & Partners, consulting engineers, Westminster, and from that date had been engaged in reporting on and carrying out experimental work, particularly in connection with nitrogen fixation and electro-chemical processes in various parts of the world.

MR. RICHARD WOOD, a member of John Wood & Sons, of Wigan, engineers and manufacturers of colliery plant, has died at the age of fifty-two years. The deceased gentleman was never robust, and for a number of years he had resided at Southport, but maintained an active interest with the business of his firm all along. The deceased was the son of the late Mr. John Wood, J.P., of Wigan, the founder of John Wood & Sons, Barley Brook Foundry, Frog Lane, Wigan. After receiving his education at the Wigan High School he was apprenticed as a mining engineer with the Moss Hall Coal Company, Limited, Ince, Wigan, and on qualifying for his profession he became associated with John Wood & Sons, of which he was a director at the time of his death. For seven or eight years he represented his firm in South Africa, and resided in Johannesburg.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Impending developments on the part of the Government and the railway companies in the direction of relieving unemployment have imparted a more optimistic tone to the Cleveland pig-iron markets, and with the growing conviction that prices have now reached about the lowest likely levels, consumers are placing orders much more freely than has been experienced of late. But the present position in the foundry industry is by no means satisfactory, and there is, therefore, but little inducement to depart from the hand-to-mouth policy so consistently followed for months past. Business badly needs a stimulus, and that must come in the first instance from the effects of a settlement of the boilermakers' strike. Export business is somewhat better. A fair number of parcels are changing hands for the Continent, but at present there would seem little prospect of much expansion in this direction. Still, the position generally is certainly better than it was a week or two ago, and sellers in this week's market were somewhat firmer in their ideas. Makers, who were recently disposed to accept 95s. 6d. for No. 3, stiffened up to 100s. again, and though probably the latter could be shaded here and there, it is now the more general quotation. No. 1 stands at 107s. 6d., No. 4 foundry 99s., and No. 4 forge 98s.

The hematite market on Tees-side is very steady and unchanged, though it would not be surprising, having regard to the many new schemes of work announced, to see a distinct improvement in values in the near future. As a matter of fact, sellers are now very firm, and for East Coast mixed numbers 99s. 6d. per ton may now be regarded as a minimum figure. In the home trade there is more disposition to buy, and fair parcels are being sold for export. Similar conditions may be noted in the West Cumberland and North Lancashire districts, Bessemer mixed numbers remaining at £5 10s. per ton delivered at Glasgow and Sheffield, and £5 15s. per ton at Birmingham. There is some indication of a slightly quickening demand for low phosphorus iron.

MANCHESTER.—Buyers of foundry iron in the local market continue to hold off, apparently with an idea that by pursuing a waiting policy makers may be starved into submission, and accept much lower prices than are now quoted. It has been reported that the price of Midland coke is now 24s., but it is not easy yet to buy furnace coke at this price, and at present almost all the blast furnaces in Derbyshire are working on coke at 26s. per ton. Nevertheless, it is a fact that some of the Derbyshire sellers have been accepting 90s. per ton at the furnaces for No. 3 iron. There is practically no competition at present for Midland irons. Now and then a small quantity of Lincolnshire foundry iron comes on the market, and the North Staffordshire furnaces occasionally sell a few hundred tons, but practically the supply of foundry iron here comes from Derbyshire. The sale of Scotch iron in this area is almost negligible. Founders have been learning how to do without it, and in several cases they have adopted substitutes.

THE MIDLANDS.—Business in this area is still largely confined to the disposal of foundry iron, for which the present limited output is apparently quite equal to current demands, while the call for forge qualities is practically negligible. Nominally quotations remain unaltered. In view of the fact that coke has been reduced 2s. recently, probably this may be regarded as an indication of strength, for buyers are always keen in pressing to obtain the advantage of such variations in raw material. Actually, quotations are open to be shaded just as much as they have been lately. Quotations:—Northamptonshire No. 3 foundry, 90s.; Derbyshire No. 3 foundry, 90s., both net f.o.t. furnaces.

SCOTLAND.—A rather more hopeful view of the position is expressed in Scottish iron trade circles than has recently been the case, consumers having to some extent renewed buying on forward account, and a few transactions being reported to cover the first quarter of next year. The buying is not general, but is being done by consumers who have booked some work, and in the present uncertain outlook they prefer to cover their requirements rather than risk losing what little profit, if any, which they have on the orders taken. The price of No. 3 is steady at 99s. at furnaces. The light castings founders continue to buy Middlesbrough iron a little more freely than they have done for some time. No. 3 Cleveland is quoted round 104s., at Grahamston, but the business has been taken by merchants as the makers are not prepared to accept the price, and from the firmer tone in the Middlesbrough market it looks as if the price there might be advanced further.

Finished Iron.

With very few exceptions the manufacturing branches of the iron trade remain in an unsatisfactory condition, and in the South Staffordshire area there are still several mills which have not turned a wheel since the last coal strike, nor seem likely to as things are at present, while those that are occupied find it a very hard matter to make a profit, except, of course, the makers of marked bars. From the recent quarterly meeting a moderate amount of work has resulted, and quotations on that occasion were fairly steady, but there was nothing to suggest that a large revival is near at hand. Quotations generally are unchanged, but with some weakness in nut and bolt bars, which are reported as having been done at 5s. less than the prices current last week. The price of the imported bar is still much below that of home production, but as the time required for delivery is a month or more, consumers who are "buying short" find it more convenient and safe to procure their supplies in this country. There is still a very meagre demand for gas strip.

Steel.

Reports from the chief steel manufacturing districts indicate continued depression in most branches of the industry, with market movements extremely restricted both for home and export transactions. As concerns semi-products, the works remain fairly steadily employed on sheet and tinplate bars, specifications coming in freely. Values are unchanged. For soft steel billets, however, there is very little call, but makers are maintaining their minimum of £7 5s. in the absence of Continental competition. Makers of ferro-manganese are becoming just a little anxious as to the immediate future. The home business has fallen away considerably, and although there are numerous inquiries on export account very few of these materialise. A good indication of present conditions is provided by the fact that the makers have reduced their prices to £17 10s. for both the home and export trade. The tone of the tinplate market is firm. The inquiry during the past week has been quite good, and a very fair proportion of business has resulted for delivery over the rest of the year. Most buyers require quick delivery, but nearly all the mills are now fully booked up for November. Current quotations for the standard sizes are firm, as follow:—Cokes, IC 14 by 20, 112 sheets, 108 lbs., 23s. 1½d. per box; IC 28 by 20, 112 sheets, 216 lbs., 46s. 3d. per box; IC 28 by 20, 56 sheets, 108 lbs., 23s. 7½d. per box, lights at ¾d. per lb. reduction, net cash, f.o.b. Bristol Channel ports.

Scrap.

Conditions generally in the scrap material markets are reported a shade more satisfactory than has lately been experienced, although still leaving much to be desired as far as the volume of business transacted is concerned. Taking the Lancashire area as fairly representative of the market position, there is little change to report, the demand for cast scrap being, of course, restricted by the small amount of work now available for the ironfoundries; but when the industry is more fully employed it is fairly certain that the excessive difference between the values of broken machinery cast scrap and ordinary pig-iron will diminish. Mixtures can, it is said, be improved by the use of a fine quality of cast scrap, but there should be a better demand for this when the foundries again get busy. The general quotations for good cast scrap now range from 77s. 6d. per ton to 85s. per ton, according to quality and place of delivery. In Scotland it is still difficult to secure cast-iron scrap of any description. This is, of course, to a certain extent accounted for by the steel works having taken up considerable quantities for the last six or seven months. Heavy machinery metal and scrap railway chairs are very scarce, and sellers show no anxiety to sell under 95s. and 97s. 6d. per ton, ordinary cast-iron scrap about 87s. 6d., light cast-iron and furnace firebars 70s. per ton.

Metals.

Copper.—The outlook in the standard copper market at the moment continues somewhat obscure, values fluctuating from day to day, though within narrow compass, having a generally weakening tendency coinciding with similar movements in the States. At present the prevailing policy of consumers is to hold off as long as possible, but considerable orders await placing, and if a steady market were maintained at or about the present level, a return of confidence among

consumers would mean buying on an important scale. Current quotations :—*Cash* : Thursday, £61 ; Friday, £60 12s. 6d. ; Monday, £60 7s. 6d. ; Tuesday, £60 5s. ; Wednesday, £59 15s. *Three Months* : Thursday, £61 12s. 6d. ; Friday, £61 7s. 6d. ; Monday, £61 ; Tuesday, £60 17s. 6d. ; Wednesday, £60 10s.

Tin.—The general tendency in this market may be reported as firm, although some slackening of American buying has been noted. Sales reported in the East have been fewer, while shipments for this month are still estimated at 5,500 tons. Whilst active conditions are reported to be still ruling in the tinplate trade, demand for tin on the part of consumers has not been particularly heavy, either here or in the U.S.A., the position in consequence of the heavy backwardation rather tending to create mistrust and lack of confidence. Current quotations :—*Cash* : Thursday, £204 ; Friday, £204 ; Monday, £201 15s. ; Tuesday, £202 5s. ; Wednesday, £204 10s. *Three Months* : Thursday, £201 17s. 6d. ; Friday, £201 15s. ; Monday, £200 ; Tuesday, £200 5s. ; Wednesday, £202.

Spelter.—The slight decline in values reported in this metal last week has been followed by a speedy recovery, an improvement due it is suggested more to the result of influential support than to any increase in home consumption. The anticipated demand from both Japan and India has not yet materialised to any great extent, although it is stated that a certain amount of business in galvanised sheets has been booked for forward deliveries. Current quotations :—*Ordinary* : Thursday, £33 15s. ; Friday, £33 12s. 6d. ; Monday, £33 7s. 6d. ; Tuesday, £33 7s. 6d. ; Wednesday, £33 5s.

Lead.—In the market for soft foreign pig values have now reached the highest level touched since April last, and the tendency continues firm. Supplies have been very irregular, and the market is feeling the effect of the absence of Spanish metal, whilst Colonial descriptions have recently been very short. As far as can be ascertained, there will be no arrivals of importance until the end of the month, when larger shipments of Mexican and United States lead are expected, pending which the near position will be extremely strained. Current quotations :—*Soft foreign (prompt)* : Thursday, £27 7s. 6d. ; Friday, £27 12s. 6d. ; Monday, £28 ; Tuesday, £28 15s. ; Wednesday, £28 15s.

Gazette.

A WINDING-UP order has been made against the Reliance Iron and Steel (Llanelly), Limited, Bank Chambers, Cowell Street, Llanelly.

MESSRS. R. D. BREE, P. BREE, AND W. LAIDLAW, engineers, Steanard Lane, Mirfield, trading under the style of Bree, Laidlaw & Company, have dissolved partnership.

THE SHAREHOLDERS of the Pleck Foundry Company, Limited, have decided to wind up the company voluntarily. Mr. A. H. Bishop, Bloxwich, has been appointed liquidator.

MESSRS. J. H. F. BALE and H. J. MILLARD, engineers and founders, 98, Bath Road, Bridgwater, trading under the style of Bale Millard & Sons, have dissolved partnership.

THE PUBLIC EXAMINATION of Mr. A. T. Pryce, brassfounder, Empire Works, Holliday Street, Birmingham, trading under the style of A. T. Pryce & Company, has been fixed for November 16.

MESSRS. H. DENTON, F. W. W. CLUCAS, AND L. W. H. CLUCAS, metal merchants, 25, Marton Burn Road, Middlesbrough, trading under the style of the Commercial Freight & General Agency, have dissolved partnership.

THE EXAMINATION TOOK place at the Sheffield Bankruptcy Court recently of Messrs. G. Peacock and D. Peacock, trading as Peacock Brothers, engineers, Sheffield Road, Tinsley. The gross liabilities are £2,255, of which £1,000 is covered by securities, and £184 is preferential and payable in full. The amount estimated to rank for dividend is £1,070, and the assets available to meet this are valued at £823. The debtors lost substantial sums on certain Government contracts. The examination was closed.

Patent Specifications Accepted.

Wade, H., die-casting apparatus (204,743) : Arthur, A. E., Lambert, G. E., and Smith, A., chaplets for use in foundry work (204,924) : Malzacher, W., runners for use in foundry moulding (193,383).

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